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June 1961

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Public Health Service • Division of Radiological Health

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SECTION I.—AIR

Radiation Surveillance Network

Division of Radiological Health, Public Health Service

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fallout from nuclear weapons tests. Although no nuclear tests have been conducted by the United States since 1958, the program has proved sufficiently valuable that it has been extended to a round-the-year basis and currently consists of 45 stations at urban locations (see fig. 1) operated by State and local health department personnel, with 2 stations operated by U.S. Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment, and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. However, field measurements do enable the operator to estimate the amount of beta activity of particulates in the air at the station 5 hours after collection by comparison with a known source using a portable survey meter. The filters are then forwarded to the central laboratory of the Radiation Surveillance Network in Washington, D.C., for a more refined measurement using a thin window proportional counter. The stations located at Atlanta, Ga., and Cincinnati, Ohio, conduct their own laboratory analyses.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a carbon-loaded cellulose dust filter using a high volume air sampler. The radioactive material in fallout adhering to small dustlike particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples.

About 85 percent of the stations collect samples of precipitation which are sent to Washington, D.C., for analysis. Values are now below limits of detection by present instrumentation. New equipment is being procured to measure lower values. Measurements have indicated that the bulk of deposited activity occurs through precipitation, but concentrations in surface air are not directly related to the amount deposited through precipitation.

Table 1 presents a summary of the data for November 1960.

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS

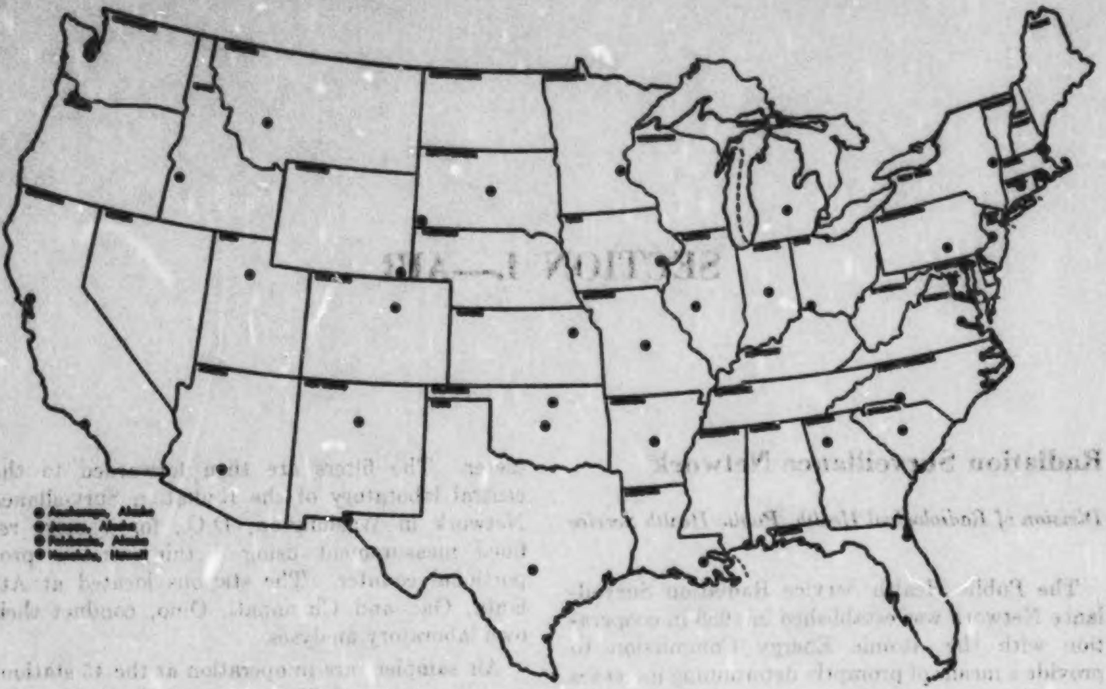


TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR—GROSS BETA DETERMINATIONS

Public Health Service Radiation Surveillance Network, November 1960

Station location	Number samples	Maximum (μμc/m³)	Minimum (μμc/m³)	Weighted average (μμc/m³)
Anchorage, Alaska	20	0.10	<0.10	<0.10
Fairbanks, Alaska	20	<.10	<.10	<.10
Juneau, Alaska	19	<.10	<.10	<.10
Phoenix, Ariz.	8	.15	<.10	.11
Little Rock, Ark.	16	<.10	<.10	<.10
Berkeley, Calif.	19	<.10	<.10	<.10
Los Angeles, Calif.	19	.12	<.10	<.10
Denver, Colo.	14	.15	<.10	<.10
Hartford, Conn.	25	.11	<.10	<.10
District of Columbia	20	<.10	<.10	<.10
Jacksonville, Fla.	17	<.10	<.10	<.10
Atlanta, Ga.	17	.17	.09	.08
Honolulu, Hawaii	19	<.10	<.10	<.10
Boise, Idaho	8	<.10	<.10	<.10
Springfield, Ill.	22	<.10	<.10	<.10
Indianapolis, Ind.	20	<.10	<.10	<.10
Iowa City, Iowa	20	.13	<.10	<.10
Topeka, Kans.	(1)	(1)	(1)	(1)
New Orleans, La.	6	<.10	<.10	<.10
Baltimore, Md.	18	.12	<.10	<.10
Lawrence, Mass.	19	<.10	<.10	<.10
Lansing, Mich.	20	.10	<.10	<.10
Minneapolis, Minn.	8	<.10	<.10	<.10
Pascagoula, Miss.	16	.26	<.10	<.12
Jefferson, Mo.	19	<.10	<.10	<.10
Helena, Mont.	18	<.10	<.10	<.10
Trenton, N.J.	7	.18	<.10	.11
Santa Fe, N. Mex.	18	<.10	<.10	<.10
Albany, N.Y.	24	.13	<.10	<.10
Gastonia, N.C.	21	.24	<.10	<.11
Cincinnati, Ohio	20	.16	.00	.04
Oklahoma City, Okla.	16	.10	<.10	<.10
Ponca City, Okla.	20	<.10	<.10	<.10
Portland, Oreg.	19	.22	<.10	.11
Harrisburg, Pa.	16	.12	<.10	<.10
Providence, R.I.	18	<.10	<.10	<.10
Columbia, S.C.	7	.11	<.10	<.10
Pierre, S. Dak.	5	<.10	<.10	<.10
Austin, Tex.	20	<.10	<.10	<.10
El Paso, Tex.	17	.22	<.10	<.14
Salt Lake City, Utah	20	.12	<.10	<.10
Richmond, Va.	18	<.10	<.10	<.10
Seattle, Wash.	10	<.10	<.10	<.10
Cheyenne, Wyo.	8	<.10	<.10	<.10
Madison, Wis.	18	<.10	<.10	<.10

---

[1] No samples received.

TABLE 2.—RADON AND THORON MEASUREMENTS

Public Health Service Radiation Surveillance Network Station at Cincinnati, Ohio, November 1960

Date	Continuous sample collection: Sample change time	Sample period (hours)	Volume (m³)	Radon[a] a.m. (μμc/m³)	Radon[b] p.m. (μμc/m³)	Thoron[c] (μμc/m³)	Beta[d] activity (μμc/m³)
1	0818	24.1	23.8	220	140	1.2	0.01
2	0810	23.9	23.7	380	160	2.2	.02
3	[illegible]	24.3	23.4	90	70	1.6	.1
4	[illegible]	24.0	23.5	420	150	8.0	.02
7	[illegible]	71.8	23.3	300	70	2.6	.03
8	0815	23.8	23.4	270	150	4.4	.0
9	[illegible]	24.6	23.4	140	120	1.9	.04
10	[illegible]	22.8	23.2	100	150	.9	.0
14	0812	95.7	117.7	370	[illegible]	4.2	.03
15	0815	24.0	23.8	240	120	2.6	.05

Date	Continuous sample collection: Sample change time	Sample period (hours)	Volume (m³)	Radon[a] a.m. (μμc/m³)	Radon[b] p.m. (μμc/m³)	Thoron[c] (μμc/m³)	Beta[d] activity (μμc/m³)
16	0830	24.0	23.9	80	220	1.4	.05
17	0821	23.9	23.4	380	140	2.4	.06
18	0816	23.9	23.5	480	200	4.6	.03
21	0820	72.0	[illegible]	750	280	7.4	.06
22	0820	23.9	27.8	970	310	6.7	.08
23	0830	23.9	23.1	220	80	1.7	.01
25	0840	49.3	50.2	270	210	2.3	.03
28	0810	70.5	55.0	130	120	2.1	.07
29	0805	23.9	23.0	150	180	1.2	.1
30	0820	24.2	23.6	90	100	1.1	.07
Average				330	160	3.4	.04

[a] Radon concentrations are derived from alpha measurements determined immediately after the sampling period (24–96 hours) has ceased. Reported radon concentrations have been corrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±20 and ±80 μμc/m³.

[b] Radon concentrations are derived from alpha measurements made in the afternoon approximately 7 hours (3 p.m.) after the new sampling period has begun. Reported radon concentrations are uncorrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±10.0 and ±30.0 μμc/m³.

[c] Thoron concentrations are derived from alpha measurements made from the same filters used in footnote (a), above, but are counted approximately 7 hours after the sampling period has ceased. Twice the standard deviation (2σ) falls between ±0.2 and ±3.5 μμc/m³.

[d] Gross beta concentrations are based on measurements made at least 4 days after each sampling period (24–96 hours) has ceased. Twice the standard deviation (2σ) falls between ±0.0 and ±0.1 μμc/m³.

National Air Sampling Network

Division of Air Pollution, Public Health Service

The Public Health Service developed its National Air Sampling Network in 1953 to secure basic data on the nature and extent of air pollution throughout the United States, and to detect trends in levels of pollution with respect to time, location, population density, climate, and other factors associated with air quality.

The current basic network consists of 103 sampling stations operating every year in 66 large cities and 37 nonurban areas. In addition to these every-year stations, 126 cities have stations which operate every other year. Thus, there are 229 sampling stations in all, of which about 166 are active in any given year. A list of National Air Sampling Network stations appeared in *Radiological Health Data*, Volume 1, No. 2.

The network stations are manned by Federal, State, and local agencies cooperating with the Division of Air Pollution, PHS. Twenty-four-hour samples of suspended particulate matter, representing approximately 2,000 cubic meters of air, are collected on glass-fiber filters on a biweekly random sampling schedule. The analyses of these samples include the measurement of total quantity of suspended particulate matter, the organic matter soluble in benzene, and gross beta radioactivity. Selected samples are analyzed also for nitrates and sulfates and for a number of metals.

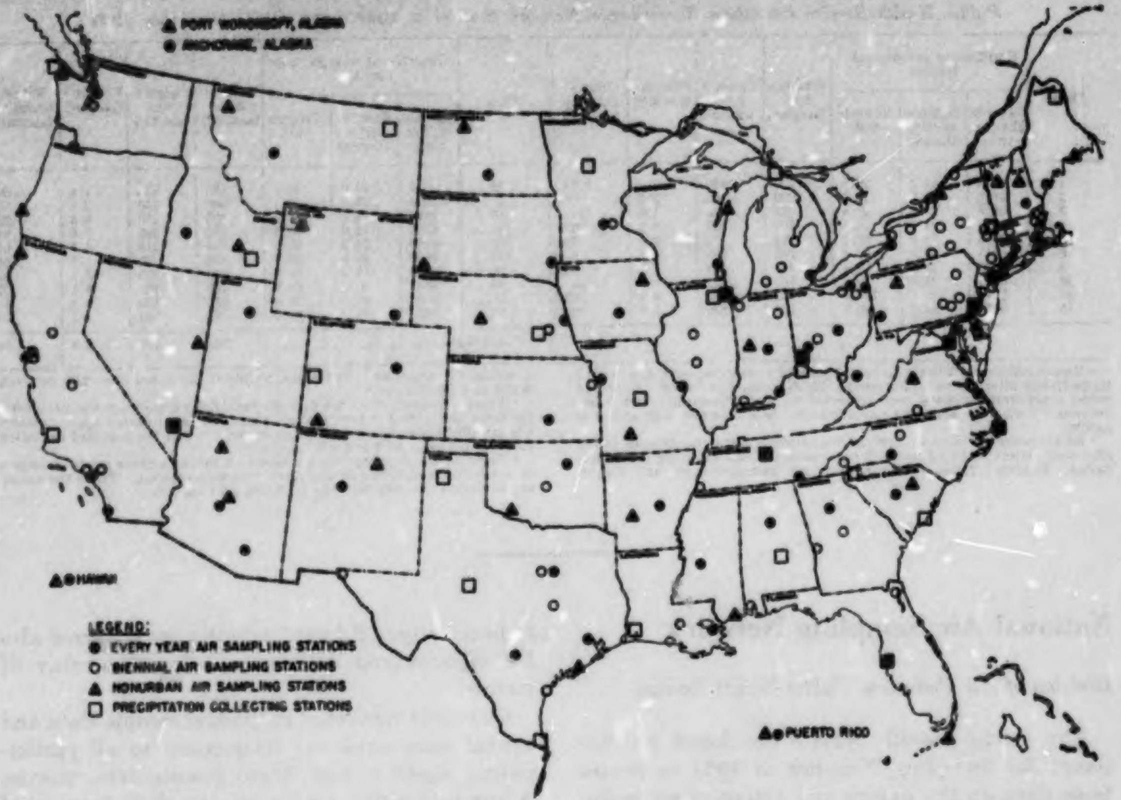
Quarterly reports of individual sample data and annual summaries are distributed to all participating agencies and State health departments. A comprehensive report on the first 5 years of operation of the network is contained in the publication, "Air Pollution Measurements of the National Air Sampling Network," Public Health Service Publication No. 637, 1958, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., price $2. Gross beta activity data, by States, for the years 1953 through 1958 were submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, Public Health Service, in testimony before the Joint Committee on Atomic Energy "Hearings on Fallout from Nuclear Weapons Tests," Volume 1, May 1959, pages 173–185.

Previous data on gross beta activities of particulates in air were published in *Radiological Health Data*, Volume I, Nos. 7 and 8, and Volume II, No. 1. The fourth-quarter 1960 data and the 1960 annual summary data are presented in tables 3 and 4, respectively.

Data from several stations are not included in the annual summary due to the small number of samples collected during 1960. Most of the data

5<

Figure 2.—PUBLIC HEALTH SERVICE NATIONAL AIR SAMPLING NETWORK SAMPLING STATIONS


▲ FORT WORONZOFF, ALASKA
● ANCHORAGE, ALASKA
▲● HAWAII
LEGEND:
● EVERY YEAR AIR SAMPLING STATIONS
○ BIENNIAL AIR SAMPLING STATIONS
▲ NONURBAN AIR SAMPLING STATIONS
☐ PRECIPITATION COLLECTING STATIONS
▲● PUERTO RICO

from these stations have been published in previous quarterly reports. In the 1960 annual summary data for San Juan, P.R. (table 4), the maximum value is 26.3 $\mu\mu c/m^3$ and the average is 1.3 $\mu\mu c/m^3$. The results for the sample with the high activity were not included in the first quarter because the sample was held in the counting room for further study and the results were not available in time for publishing in *Radiological Health Data*, Volume I, No. 8. The high value, which is outstanding for the year, was apparently due to the first French test.

Table 3.—GROSS BETA RADIOACTIVITY IN AIR

National Air Sampling Network, Public Health Service, Fourth Quarter 1960

[$\mu\mu c$ per cubic meter]

Station location	Number of samples	Minimum	Maximum	Average	Station location	Number of samples	Minimum	Maximum	Average
Hartford, Conn.	6	<0.1	0.1	0.1	Orange County, Vt.[1]	6	<.1	.1	.1
New Haven, Conn.	5	<.1	.1	.1	Wilmington, Del.	6	<.1	.1	.1
Stamford, Conn.	6	<.1	.1	.1	Kent County, Del.[1]	6	<.1	.1	.1
Bridgeport, Conn.	5	<.1	.1	.1	Elizabeth, N.J.	6	<.1	.1	.1
Portland, Maine	6	<.1	.1	.1	Camden, N.J.	6	<.1	.1	.1
Acadia National Park, Maine[1]	5	<.1	.1	<.1	Trenton, N.J.	1	.1	.1	.1
Boston, Mass.	6	<.1	.1	.1	East Orange, N.J.	6	<.1	.1	.1
Lawrence, Mass.	5	<.1	.1	.1	Newark, N.J.	6	<.1	.1	.1
Lynn, Mass.	6	<.1	.1	.1	New York, N.Y.	6	<.1	.1	.1
Somerville, Mass.	6	<.1	.1	.1	Binghamton, N.Y.	6	<.1	.1	.1
Fall River, Mass.	7	.1	.2	.1	Schenectady, N.Y.	5	<.1	.1	.1
Quincy, Mass.	5	<.1	.2	.1	Syracuse, N.Y.	4	<.1	.1	.1
Springfield, Mass.	6	<.1	.2	.1	Utica, N.Y.	6	<.1	.1	<.1
Manchester, N.H.	6	<.1	.1	<.1	Albany, N.Y.	6	<.1	.1	.1
Coos County, N.H.[1]	6	<.1	.1	.1	Rochester, N.Y.	6	<.1	.1	.1
Providence, R.I.	6	<.1	.1	.1	Niagara Falls, N.Y.	4	<.1	.2	.1
Washington County, R.I.	7	<.1	.1	.1	New Rochelle, N.Y.	7	.1	.2	.1
Burlington, Vt.	7	<.1	.1	<.1	Troy, N.Y.	6	<.1	.1	.1

[1] Nonurban station.

6<

TABLE 3.—GROSS BETA RADIOACTIVITY IN AIR—Continued

Station location	Number of samples	Minimum	Maximum	Average
Massena, N.Y.	6	<.1	.1	.1
Glen Cove, N.Y.	4	<.1	.1	.1
Elmira, N.Y.	7	<.1	.1	.1
Mount Vernon, N.Y.	6	<.1	.1	.1
Cape Vincent, N.Y.	6	<.1	.1	.1
Philadelphia, Pa.	6	<.1	.1	.1
Pittsburgh, Pa.	6	<.1	.1	.1
Harrisburg, Pa.	6	<.1	.1	.1
Reading, Pa.	6	<.1	.2	.1
Wilkes-Barre, Pa.	6	.1	.2	.1
Clarion County, Pa.[1]	6	<.1	.2	.1
Washington, D.C.	6	<.1	.1	.1
Louisville, Ky.	2	.1	.1	.1
Baltimore, Md.	7	<.1	.1	.1
Calvert County, Md.[1]	6	<.1	.1	.1
Charlotte, N.C.	7	<.1	.2	.1
Winston-Salem, N.C.	5	.1	.1	.1
Asheville, N.C.	6	<.1	.1	.1
Cape Hatteras, N.C.[1]	7	<.1	.1	.1
San Juan, P.R.	6	<.1	.1	.1
Loquillo Mountains, P.R.[1]	6	<.1	.1	<.1
Norfolk, Va.	6	.1	.1	.1
Hampton, Va.	7	.1	.1	.1
Danville, Va.	6	<.1	.1	.1
Shenandoah National Park, Va.[1]	6	.1	.1	.1
Charleston, W. Va.	6	<.1	.2	.1
Huntington, W. Va.	6	.1	.1	.1
Birmingham, Ala.	6	.1	.1	.1
Mobile, Ala.	6	.1	.1	.1
Tampa, Fla.	6	.1	.1	.1
Jacksonville, Fla.	6	.1	.1	.1
Florida Keys, Fla.[1]	5	<.1	.1	<.1
Atlanta, Ga.	5	<.1	.1	.1
Columbus, Ga.	6	<.1	.1	.1
Macon, Ga.	6	<.1	.1	.1
Jackson, Miss.[1]	6	.1	.2	.1
Jackson County, Miss.	6	.1	.1	.1
Columbia, S.C.	1	.1	.1	.1
Greenville, S.C.	7	.1	.1	.1
Richland County, S.C.[1]	7	<.1	.1	.1
Chattanooga, Tenn.	5	<.1	.1	.1
Nashville, Tenn.	6	<.1	.1	.1
Memphis, Tenn.	5	.1	.1	.1
Chicago, Ill.	6	<.1	.1	.1
Springfield, Ill.	7	<.1	.1	.1
Peoria, Ill.	3	.1	.2	.1
East Chicago, Ind.	6	<.1	.2	.1
Evansville, Ind.	6	<.1	.1	.1
Fort Wayne, Ind.	6	<.1	.1	.1
Indianapolis, Ind.	5	.1	.1	.1
Gary, Ind.	5	.1	.1	.1
Montgomery County, Ind.[1]	6	<.1	.1	.1
Detroit, Mich.	6	<.1	.1	.1
Kalamazoo, Mich.	5	<.1	.1	.1
Lansing, Mich.	6	<.1	.1	.1
Saginaw, Mich.	6	<.1	.2	.1
Cincinnati, Ohio	5	.1	.1	.1
Youngstown, Ohio	6	.1	.1	.1
Cleveland, Ohio	6	<.1	.2	.1
Columbus, Ohio	6	<.1	.2	.1
Lorain, Ohio	6	<.1	.1	.1
Akron, Ohio	6	<.1	.1	.1
Dayton, Ohio	6	.1	.2	.1
Springfield, Ohio	6	.1	.1	.1
Milwaukee, Wis.	6	<.1	.1	.1
Racine, Wis.	5	<.1	.1	.1
Door County, Wis.[1]	6	<.1	.1	.1
Des Moines, Iowa	6	<.1	.2	.1
Clayton County, Iowa[1]	6	<.1	.3	.1
Kansas City, Kans.	6	<.1	.1	.1
Wichita, Kans.	5	<.1	.2	.1
Minneapolis, Minn.	7	<.1	.1	.1
St. Paul, Minn.	6	<.1	.1	.1
Kansas City, Mo.	6	<.1	.1	.1
St Louis, Mo.	6	<.1	.1	.1
Omaha, Nebr.	6	<.1	.1	.1
Lincoln, Nebr.	4	<.1	.1	.1
Thomas County, Nebr.[1]	7	<.1	.1	.1
Bismarck, N. Dak.	6	<.1	.1	.1
Ward County, N. Dak.[1]	7	<.1	.1	<.1
Sioux Falls, S. Dak.	6	<.1	.1	.1
Black Hills Forest, S. Dak.[1]	3	.1	.1	.1
Little Rock, Ark.	6	.1	.1	.1
Montgomery County, Ark.[1]	6	.1	.1	.1
New Orleans, La.	6	<.1	.1	.1
Baton Rouge, La.	6	.1	.1	.1
Albuquerque, N. Mex.	6	.1	.5	.2
Colfax County, N. Mex.[1]	7	<.1	.2	.1
Tulsa, Okla.	7	<.1	.1	.1
Oklahoma City, Okla.	6	.1	.1	.1
Cherokee County, Okla.[1]	5	<.1	.1	.1
Fort Worth, Tex.	6	<.1	.1	.1
Houston, Tex.	6	<.1	.1	.1
Dallas, Tex.	5	<.1	.1	.1
San Antonio, Tex.	5	<.1	.1	.1
El Paso, Tex.	6	.1	.2	.1
Corpus Christi, Tex.	6	<.1	.1	.1
Waco, Tex.	6	<.1	.1	.1
Denver, Colo.	6	<.1	.2	.1
Montezuma County, Colo.[1]	6	.1	.3	.2
Boise, Idaho	5	<.1	.1	.1
Butte County, Idaho.[1]	6	<.1	.3	.1
Helena, Mont.	6	<.1	.1	.1
Glacier National Park, Mont.[1]	6	<.1	.1	<.1
Salt Lake City, Utah	7	.1	.2	.1
Cheyenne, Wyo.	6	<.1	.4	.1
Yellowstone Park, Wyo.[1]	7	<.1	.1	.1
Anchorage, Alaska	6	<.1	.1	.1
Point Woronzof, Alaska[1]	6	<.1	.1	.1
Phoenix, Ariz.	7	<.1	.2	.1
Tucson, Ariz.	6	.1	.2	.1
Maricopa County, Ariz.[1]	7	<.1	.1	.1
Grand Canyon Park, Ariz.[1]	7	.1	.1	.1
Los Angeles, Calif.	6	<.1	.3	.1
San Francisco, Calif.	6	<.1	.1	<.1
Pasadena, Calif.	6	.1	.1	.1
San Diego, Calif.	6	.1	.2	.1
Burbank, Calif.	6	<.1	.2	.1
Fresno, Calif.	5	<.1	.1	.1
Oakland, Calif.	5	<.1	.1	.1
Sacramento, Calif.	6	.1	.1	.1
Richmond, Calif.	6	<.1	.1	.1
Humboldt County, Calif.[1]	5	<.1	.1	.1
Honolulu, Hawaii	6	<.1	.1	<.1
Barbers Point, Ewa, Hawaii[1]	6	<.1	.1	<.1
Las Vegas, Nev.	5	.1	.2	.2
White Pine County, Nev.[1]	7	.1	.3	.1
Portland, Oreg.	5	<.1	.1	<.1
Curry County, Oreg.[1]	4	<.1	.1	.1
Seattle, Wash.	6	<.1	.1	<.1
Tacoma, Wash.	6	<.1	.1	.1

[1] Nonurban station.

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TABLE 4.—GROSS BETA RADIOACTIVITY IN AIR

National Air Sampling Network, Public Health Service, Annual Summary 1960

[μμc per cubic meter]

Station location	Number of samples	Minimum	Maximum	Average
Hartford, Conn.	26	<0.1	0.3	0.1
New Haven, Conn.	25	<.1	.3	.1
Stamford, Conn.	26	<.1	.4	.1
Bridgeport, Conn.	26	<.1	.3	.1
Portland, Maine	26	<.1	.3	.1
Acadia National Park, Maine¹	26	<.1	.4	.1
Boston, Mass.	26	<.1	.3	.1
Lawrence, Mass.	25	<.1	.2	.1
Lynn, Mass.	26	<.1	.1	.1
Somerville, Mass.	26	<.1	.3	.1
Fall River, Mass.	25	<.1	.3	.1
Quincy, Mass.	26	<.1	.3	.1
Springfield, Mass.	21	<.1	.3	.1
Manchester, N.H.	21	<.1	.3	.1
Coos County, N.H.¹	24	<.1	.2	.1
Providence, R.I.	26	<.1	.3	.1
Washington County, R.I.¹	27	<.1	.2	.1
Burlington, Vt.	25	<.1	.3	.1
Orange County, Vt.¹	25	<.1	.3	.1
Wilmington, Del.	24	<.1	.5	.2
Kent County, Del.¹	20	<.1	.2	.1
Elizabeth, N.J.	24	<.1	.2	.1
Camden, N.J.	25	<.1	.2	.1
East Orange, N.J.	26	<.1	.2	.1
Newark, N.J.	25	<.1	.2	.1
New York, N.Y.	25	<.1	.3	.1
Binghamton, N.Y.	24	<.1	.3	.1
Schenectady, N.Y.	25	<.1	.2	.1
Syracuse, N.Y.	26	<.1	.3	.1
Utica, N.Y.	25	<.1	.2	.1
Albany, N.Y.	26	<.1	.2	.1
Rochester, N.Y.	26	<.1	.3	.1
Niagara Falls, N.Y.	19	<.1	.5	.2
New Rochelle, N.Y.	25	<.1	.3	.1
Troy, N.Y.	22	<.1	.2	.1
Massena, N.Y.	25	<.1	.3	.1
Glen Cove, N.Y.	22	<.1	.2	.1
Elmira, N.Y.	26	<.1	.4	.1
Mount Vernon, N.Y.	20	<.1	.3	.1
Cape Vincent, N.Y.¹	22	<.1	.3	.1
Philadelphia, Pa.	26	<.1	.4	.1
Pittsburgh, Pa.	25	<.1	.2	.1
Harrisburg, Pa.	25	<.1	.2	.1
Reading, Pa.	26	<.1	.3	.1
Wilkes-Barre, Pa.	25	<.1	.3	.1
Clarion County, Pa.¹	26	<.1	.4	.1
Washington, D.C.	22	<.1	.3	.2
Baltimore, Md.	25	<.1	.3	.1
Calvert County, Md.¹	24	<.1	.3	.1
Charlotte, N.C.	26	<.1	.4	.2
Winston Salem, N.C.	25	.1	.4	.2
Asheville, N.C.	26	<.1	.4	.2
Cape Hatteras, N.C.¹	24	<.1	.2	.1
San Juan, P.R.	22	<.1	26.3	1.3
Luquillo Mountains, P.R.¹	24	<.1	.6	.1
Norfolk, Va.	25	<.1	.2	.1
Hampton, Va.	26	.1	.4	.2
Danville, Va.	25	<.1	.3	.1
Shenandoah National Park, Va.¹	26	<.1	.3	.1
Charleston, W. Va.	25	<.1	.5	.2
Huntington, W. Va.	24	<.1	.3	.1
Birmingham, Ala.	25	<.1	.4	.1
Mobile, Ala.	25	<.1	.4	.1
Tampa, Fla.	26	<.1	1.2	.2
Jacksonville, Fla.	25	<.1	.5	.2
Florida Keys, Fla.¹	21	<.1	.4	.1
Atlanta, Ga.	23	<.1	.4	.2
Columbus, Ga.	25	<.1	.4	.2
Macon, Ga.	26	<.1	.4	.1
Jackson, Miss.¹	24	<.1	.3	.1
Jackson County, Miss.	23	<.1	.3	.1
Columbia, S.C.	23	.1	.4	.2
Greenville, S.C.	25	<.1	.5	.2
Richland County, S.C.¹	26	<.1	.4	.1
Chattanooga, Tenn.	25	<.1	.5	.2
Nashville, Tenn.	26	<.1	.4	.2
Memphis, Tenn.	25	<.1	.4	.1
Chicago, Ill.	22	<.1	.3	.1
Springfield, Ill.	20	<.1	.3	.1
Peoria, Ill.	19	.1	.4	.2
East Chicago, Ind.	23	<.1	.2	.1
Evansville, Ind.	26	<.1	.3	.2
Fort Wayne, Ind.	26	<.1	.3	.1
Indianapolis, Ind.	25	.1	.4	.2
Gary, Ind.	24	<.1	.3	.1
Montgomery County, Ind.¹	26	<.1	.4	.1
Detroit, Mich.	26	<.1	.3	.1
Kalamazoo, Mich.	25	<.1	.3	.1
Lansing, Mich.	25	<.1	.2	.1
Saginaw, Mich.	26	<.1	.4	.1
Cincinnati, Ohio	24	<.1	.3	.1
Youngstown, Ohio	26	<.1	.2	.1
Cleveland, Ohio	26	<.1	.3	.1
Columbus, Ohio	25	<.1	.4	.1
Lorain, Ohio	26	<.1	.3	.1
Akron, Ohio	26	<.1	.3	.1
Dayton, Ohio	26	<.1	.3	.1
Springfield, Ohio	26	.1	.4	.2
Milwaukee, Wis.	24	<.1	.6	.1
Racine, Wis.	22	<.1	.2	.1
Door County, Wis.¹	26	<.1	.3	.1
Des Moines, Iowa	25	<.1	.4	.2
Clayton County, Iowa¹	26	<.1	.4	.1
Kansas City, Kans.	26	<.1	.3	.1
Wichita, Kans.	22	<.1	.5	.2
Minneapolis, Minn.	26	<.1	.3	.1
St. Paul, Minn.	25	<.1	.3	.1
Kansas City, Mo.	26	<.1	.3	.2
St. Louis, Mo.	26	<.1	.3	.1
Omaha, Nebr.	26	<.1	.4	.1
Lincoln, Nebr.	25	<.1	.3	.1
Thomas County, Nebr.¹	25	<.1	.4	.1
Bismarck, N. Dak.	25	<.1	.4	.1
Ward County, N. Dak.¹	23	<.1	.3	.1
Sioux Falls, S. Dak.¹	22	<.1	.5	.1
Black Hills Forest, S. Dak.¹	10	<.1	.3	.1
Little Rock, Ark.	26	<.1	.3	.1
Montgomery County, Ark.¹	26	<.1	.4	.1
New Orleans, La.	26	<.1	.3	.1
Baton Rouge, La.	25	<.1	.7	.2
Albuquerque, N. Mex.	25	.1	.5	.2
Colfax County, N. Mex.¹	22	<.1	.3	.1
Tulsa, Okla.	17	<.1	.3	.1
Oklahoma City, Okla.	23	<.1	.3	.2
Cherokee County, Okla.¹	24	<.1	.4	.2
Fort Worth, Tex.	26	<.1	.4	.1
Houston, Tex.	26	<.1	.5	.1
Dallas, Tex.	22	<.1	.4	.1
San Antonio, Tex.	23	<.1	.4	.1
El Paso, Tex.	26	<.1	.8	.2
Corpus Christi, Tex.	25	<.1	.4	.1
Waco, Tex.	25	<.1	.2	.1
Denver, Colo.	25	<.1	.4	.2
Montezuma County, Colo.¹	24	<.1	.5	.2
Boise, Idaho	24	<.1	.3	.1
Butte County, Idaho¹	22	<.1	.3	.2
Helena, Mont.	26	<.1	.3	.1
Glacier National Park, Mont.¹	20	<.1	.4	.1
Salt Lake City, Utah	25	<.1	.6	.2
Cheyenne, Wyo.	23	<.1	.4	.1
Yellowstone Park, Wyo.¹	21	<.1	.3	.1
Anchorage, Alaska	26	<.1	.2	.1
Point Woronsof, Alaska¹	26	<.1	.2	.1
Phoenix, Ariz.	25	<.1	.4	.2
Tucson, Ariz.	25	.1	1.9	.3
Maricopa County, Ariz.¹	26	<.1	.5	.2
Grand Canyon Park, Ariz.¹	21	.1	.4	.2
Los Angeles, Calif.	25	<.1	.5	.1
San Francisco, Calif.	26	<.1	.3	.1
Pasadena, Calif.	26	<.1	.3	.1
San Diego, Calif.	26	<.1	.7	.1
Burbank, Calif.	26	<.1	.9	.2
Fresno, Calif.	25	<.1	.4	.2
Oakland, Calif.	24	<.1	.3	.1
Sacramento, Calif.	26	<.1	.6	.2
Richmond, Calif.	26	<.1	.5	.1
Humboldt County, Calif.¹	20	<.1	.2	.1
Honolulu, Hawaii	26	<.1	.3	.1
Barbers Point, Ewa County, Hawaii¹	26	<.1	.6	.1
Las Vegas, Nev.	21	<.1	.5	.2
White Pine County, Nev.¹	25	.1	.5	.2
Portland, Oreg.	24	<.1	.2	.1
Curry County, Oreg.	19	<.1	.2	.1
Tacoma, Wash.	23	<.1	.3	.1

¹ Nonurban station.

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Gross Beta Radioactivity in Precipitation

National Air Sampling Network, Precipitation Collection Section, Public Health Service

During 1959 a precipitation collection and analysis program was established by the Weather Bureau Research Station in Cincinnati, Ohio, and the National Air Sampling Network. The collection stations are located at Weather Bureau offices or airport stations. Monthly composite samples of precipitation are collected at 30 stations and forwarded to the network laboratory for analysis. A list of these precipitation collection stations is given below. Samples are analyzed for total solids and a large number of metals and nonmetals. In addition, samples representing 85 percent or more of the official rainfall recorded at the collecting stations are analyzed for gross beta radioactivity if a large enough volume remains after the requirements for the chemical analysis have been met.

PRECIPITATION COLLECTION STATIONS

National Air Sampling Network

Alabama: Montgomery
California: Santa Maria
Colorado: Grand Junction
Florida: Tampa
Idaho: Pocatello
Illinois:
  Chicago (Midway Airport)
  Chicago (O'Hare Airport)
Louisiana: Lake Charles
Maine: Caribou
Maryland: Silver Hill
Massachusetts: Nantucket
Michigan: Sault Ste. Marie
Minnesota: St. Cloud
Missouri: Columbia
Montana: Glasgow
Nebraska: Grand Island
Nevada: Las Vegas
New York: Albany
North Carolina: Cape Hatteras
Ohio:
  Cincinnati (research station)
  Cincinnati (airport)
Pennsylvania: Philadelphia
South Carolina:
  Charleston
  Greenville
Tennessee: Nashville
Texas:
  Brownsville
  San Angelo
  Amarillo
Virginia: Sterling
Washington: Tatoosh Island

TABLE 5.—GROSS BETA RADIOACTIVITY OF PRECIPITATION

National Air Sampling Network, Public Health Service, Fourth Quarter 1960

Station	October		November		December	
	μμc/liter	μμc/m³	μμc/liter	μμc/m³	μμc/liter	μμc/m³
Brownsville, Tex.	(a)	(a)	(a)	(a)	5	300
Caribou, Maine	(a)	(a)	(a)	(a)	6	500
Cincinnati, Ohio (airport)	17	1,600	19	1,100	11	600
Cincinnati, Ohio (WBRS)	12	800	(a)	(a)	(a)	(a)
Lake Charles, La.	9	1,100	5	600	5	1,000
Nantucket, Mass.	9	900	8	700	(a)	(a)
Nashville, Tenn.	(a)	(a)	12	800	7	600
Philadelphia, Pa.	18	1,200	(a)	(a)	12	900
San Angelo, Tex.	3	300	(a)	(a)	(a)	(a)
Sault Ste. Marie, Mich.	15	800	(a)	(a)	(a)	(a)
Sterling, Va.	(a)	(a)	(a)	(a)	7	400
Tatoosh, Wash.	(a)	(a)	19	4,200	7	1,300
Cape Hatteras, N.C.	(a)	(a)	(a)	(a)	11	1,400

a No data available due to low collection efficiency or inadequate sample.

Radioactivity Measurements in Air

U.S. Naval Research Laboratory

Radioactivity measurements of air-filter samples collected at various sites along the 80th meridian (West) are made by the U.S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during November 1960 is shown in table 6, and the radioactivity profile for the same month is shown in figure 3. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

TABLE 6.—DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION

U.S. Naval Research Laboratory, November 1960

[dpm/m³]

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal	Mauna Loa, Hawaii	Miami, Florida	Washington, D.C.	Moosonee Ontario, Canada	Thule, Greenland
1	--------	0.06	0.13	0.18	0.08	0.02	0.06	0.01	0.09	0.04	0.16	0.11	0.04
2	--------	.06	.15	.18	.06	.02	.06	.01	.09	.04	.13	.11	.04
3	--------	.06	.07	.13	.04	.10	.06	.01	.08	.23	.17	.01	.03
4	--------	.06	.07	.13	.05	.10	.09	.01	.08	.23	.17	.01	.03
5	--------	.06	.06	.09	--------	.04	.09	.04	.11	.23	.11	.05	.04
6	--------	.05	.08	.09	.08	.04	.09	.04	.11	.23	.11	.05	.04
7	--------	.06	.08	.09	.06	.04	.09	.04	.11	.23	.11	.05	.04
8	--------	--------	.11	.07	.05	.06	.09	.04	.10	.23	.07	.06	.04
9	--------	--------	.11	.07	.04	.06	.10	.04	.10	.23	.07	.06	.09
10	--------	--------	.10	.06	.06	.06	.06	.04	.04	.12	.12	.10	.05
11	--------	--------	.10	.06	.04	.05	.05	.04	.04	.15	.12	.10	.05
12	--------	--------	.06	.08	.04	.01	.05	.02	.03	.10	.12	.09	.06
13	--------	--------	.06	.08	.04	.01	.05	.02	.03	.10	.12	.09	.05
14	--------	--------	.06	.08	.04	.01	.05	.02	.03	.10	.12	.09	.06
15	--------	--------	.14	.10	.02	.06	.07	.05	.08	.09	.26	.10	--------
16	--------	--------	.14	.10	--------	.06	.07	.05	.08	.09	.26	.10	--------
17	--------	--------	.16	.11	.03	.03	.07	.03	.08	.05	.18	.03	.09
18	--------	--------	.15	.11	.02	.03	.07	.03	.08	.05	.18	.03	.09
19	--------	--------	.10	.11	.06	.03	.07	.01	.05	.14	.14	.08	.08
20	--------	--------	.10	.11	.06	.03	.07	.01	.05	.14	.14	.08	.08
21	--------	--------	.10	.11	.06	.02	.06	.01	.05	.14	.14	.08	.08
22	--------	--------	.13	.09	.07	.07	.06	.01	.05	.23	.16	.12	--------
23	--------	--------	.13	.09	.06	.07	.05	.01	.05	.23	.18	.12	.08
24	--------	--------	.11	.11	.05	.02	.05	.04	.04	.15	.09	.14	.08
25	--------	--------	.11	.11	.04	.02	.05	.04	.04	.15	.09	.14	.07
26	--------	--------	.11	--------	.04	.06	.05	.04	.05	.06	.11	.08	.07
27	--------	--------	.11	--------	.02	.06	.05	.04	.03	.06	.11	.08	.05
28	--------	--------	.11	--------	.03	.06	.09	.04	.05	.06	.11	.08	.05
29	--------	--------	.14	--------	.02	--------	.04	.02	.06	.07	.11	.04	.05
30	--------	--------	.14	--------	.02	--------	.04	.02	.08	.07	.11	.04	.10
Mean value	--------	--------	.10	.10	.05	.05	.06	.03	.07	.14	.14	.08	.06

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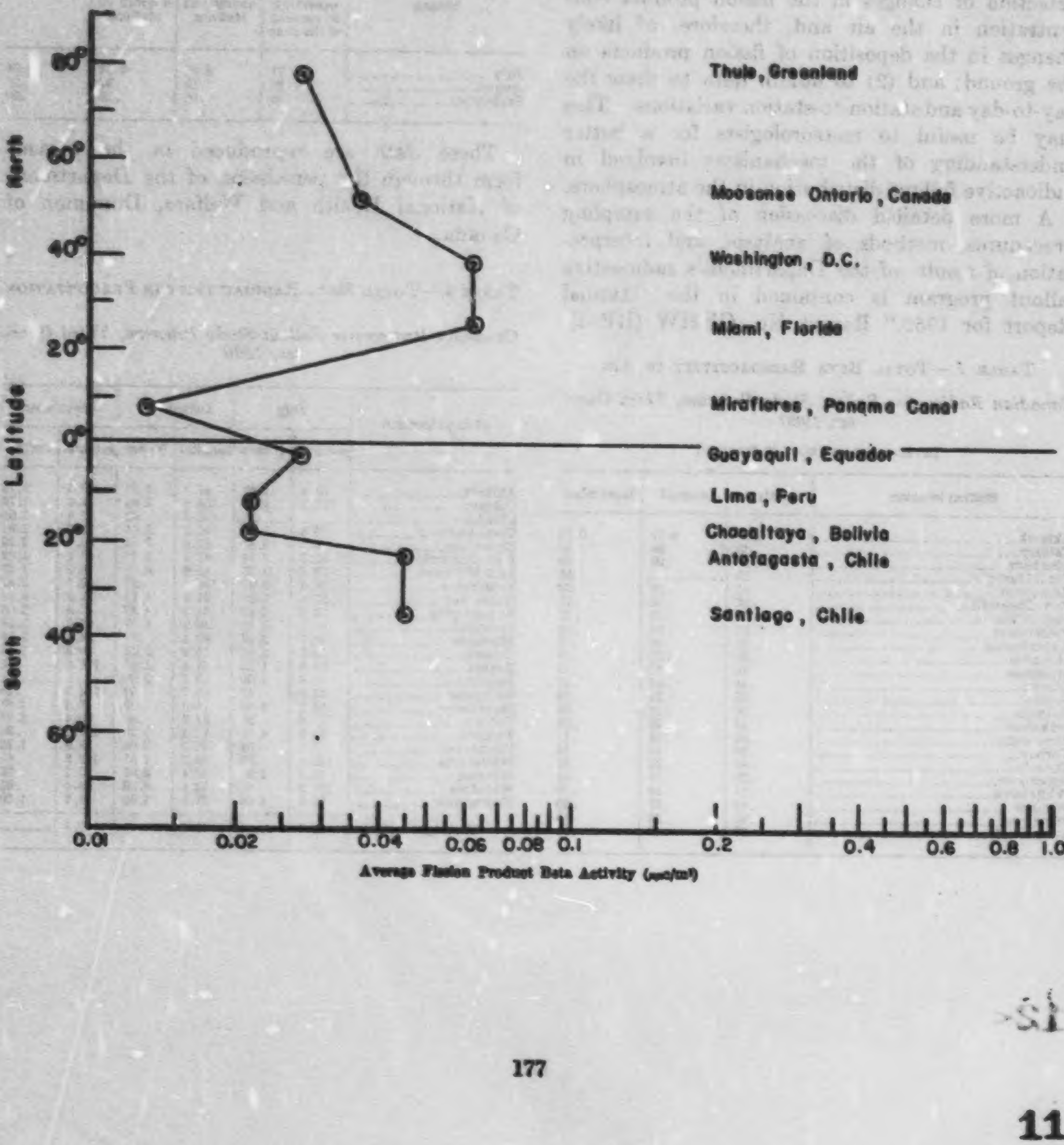
FIGURE 3.—PROFILE OF BETA ACTIVITY

Average Measurements of Surface Air
At Stations Along the 80th Meridan (West)

U.S. Naval Research Laboratory

November 1960



Canadian Radioactive Fallout Study Program

Department of National Health and Welfare, Dominion of Canada

As part of its radioactive fallout study program, the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs.

The operation of the nationwide air sampling program is conducted for two main purposes: (1) to provide a convenient method for the early detection of changes in the fission product concentration in the air and, therefore, of likely changes in the deposition of fission products on the ground; and (2) to obtain data to show the day-to-day and station-to-station variations. This may be useful to meteorologists for a better understanding of the mechanisms involved in radioactive fallout distribution in the atmosphere.

A more detailed discussion of the sampling procedures, methods of analysis, and interpretation of results of the Department's radioactive fallout program is contained in the "Annual Report for 1959," Report No. CNHW (RP-3).

TABLE 7.—TOTAL BETA RADIOACTIVITY IN AIR

Canadian Radioactive Fallout Study Program, Third Quarter, 1960

[Average concentration in dpm/m ³]

Station location	July	August	September
Aklavik	0.32	0.11	0.09
Calgary	.46	.34	.22
Chatham	.39	.30	.19
Coral Harbour	.36		.06
Edmonton	.41	.28	.20
Fort Churchill	.35	.14	.11
Fort Williams	.37	.30	.17
Fredericton	.30	.35	.15
Kapuskasing	.36	.30	.15
Montreal	.39	.32	.19
Moosonee	.36	.23	.15
Ottawa	.41	.35	.22
Regina	.36	.38	.18
Resolute	.38	.10	.08
Saskatoon	.43	.29	.20
Shearwater	.30	.28	.17
Torbay	.39	.19	.14
Toronto	.40	.35	.24
Vancouver	.36	.13	.19
Whitehorse	.18	.16	.16
Windsor	.46	.37	.25
Winnipeg	.41	.30	.18
Yellowknife	.30	.19	.11

Radiological Health Data, Volume II, No. 1, included tables on total beta activity in air for the period July 1959 through June 1960, and on the total beta activity in precipitation for 1959 and January through June 1960. Tables 7, 8, and 9 present the data for the third quarter 1960.

TABLE 8.—MONTHLY AVERAGE FISSION PRODUCT CONCENTRATION IN AIR

Canadian Radioactive Fallout Study Program, Third Quarter, 1960

[Radioactivity in dpm/m ³]

Month	Number of stations operating 80 percent of the time	Minimum average all stations	Maximum average all stations	Average
July	21	0.18	0.46	0.34
August	22	.10	.37	.25
September	23	.06	.25	.16

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TABLE 9.—TOTAL BETA RADIOACTIVITY IN PRECIPITATION

Canadian Radioactive Fallout Study Program, Third Quarter, 1960

Station location	July		August		September	
	μμc/liter	Inches	μμc/liter	Inches	μμc/liter	Inches
Aklavik	68.4	1.62	47.1	1.53	39.5	0.73
Calgary	112.5	1.05	108.4	1.04	18.2	1.79
Chatham			433.2	.40	42.6	1.98
Coral Harbour	60.8	2.47	80.2	2.04	28.0	1.91
Edmonton	56.2	3.35	42.6	3.72	33.4	2.39
Fort Churchill	62.3	2.14	47.1	2.26	47.1	1.07
Fort Williams	77.5	3.36	45.6	3.26	28.9	1.27
Fredericton	48.6	3.97	138.7	.67	16.7	2.37
Goose Bay	27.4	5.37	31.9	4.15	21.3	4.35
Kapuskasing	50.2	2.45	24.3	4.62	31.9	2.06
Montreal	44.1	3.45	56.2	1.19	24.3	2.60
Moosonee	61.7	3.67	62.8	1.37	24.3	2.19
Ottawa	39.5	2.98	15.2	2.43	50.3	1.48
Regina	96.8	1.23	66.4	1.67	270.6	.11
Resolute	67.8	1.06	13.7	2.93		
Saskatoon	15.2	.47	88.2	.82	214.3	.15
Shearwater	54.7	3.06	76.0	.90	7.5	2.67
Torbay	77.5	.88	97.3	.82	30.4	2.77
Toronto	41.0	4.11	71.4	1.28	147.4	.34
Vancouver	27.5	.04	41.0	2.06	28.9	1.13
Whitehorse	112.5	.72	86.2	1.31	102.2	.61
Windsor	80.2	1.90	39.4	3.97	55.2	.60
Winnipeg	128.2	.67	33.4	3.00	68.4	.98
Yellowknife	80.6	1.06	21.3	1.96	24.3	1.09
Average	62.7	--------	70.4	--------	60.5	--------

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SECTION II.—FOOD, OTHER THAN MILK

Strontium 90 and Calcium in U.S. Wheat and Milling Products

by J. RIVERA, *Health and Safety Laboratory, U.S. Atomic Energy Commission*

The results of analyses for strontium 90 and calcium in 1959 wheat samples, obtained from nine States, are listed in table 1.[1] Results of analyses on the milling products of the wheat from five of these States are also included. Data on the 1959 wheat crop from six additional States were previously reported in HASL–84.[2]

Using 1958 production statistics, the production-weighted average strontium 90 concentration of the wheat calculated from 15 States' samples in 1959 was $53 \pm 19 \mu\mu c$/kg.[3] This same average computed using data obtained from nine States in 1958 was $62 \pm 27 \mu\mu c$/kg. Although no statistical significance can be attached to the difference between the 1958 average strontium 90 concentration and that for 1959 due to the large standard deviations associated with these averages, one may speculate as to what factors might have influenced the difference.

Strontium 90 fallout in the 30° to 50° N. latitude belt during 1958, from pot and funnel data, is estimated to have been about 0.294 megacuries. In 1959 the strontium 90 deposition in this latitude belt is estimated to have been 0.423 megacurie. One would expect therefore that wheat harvested in 1959 should have had a higher strontium 90 concentration than wheat harvested in 1958. If, however, the deposition during the summer of 1958 and that of 1959 is compared, one finds 0.079 megacurie deposited in 1958 and 0.038 megacurie deposited in 1959. Gummed film data[4] from many of the wheat-growing States also indicate that despite the fact that there was more fallout of strontium 90 in 1959 than in 1958, during the summer harvest months the reverse was true with more strontium 90 being deposited in 1958 than in 1959.

It would seem reasonable to conclude that the strontium 90 concentration in wheat is not wholly dependent on the fallout rate immediately prior to harvest, nor is it wholly dependent on the cumulative strontium 90 content of the soil on which it grows, but rather on a combination of these factors. A reasonable assessment of the relative importance of these two factors may be possible when the 1960 crop is analyzed because it appears that the fallout rate during this year was considerably lower than in the preceding 2 years.

A comparison of the relative distribution of strontium 90 in the 1959 milling products with that obtained in 1958 is shown in table 2. In 1959, as well as in 1958, patent flour had the lowest and bran had the highest strontium 90 concentration. Comparing these concentrations with the concentration of the wheat from which they were milled, one obtains:

	1958 [1]	*1959* [2]
$\dfrac{\text{Average } \mu\mu c\ Sr^{90}/kg \text{ of bran}}{\text{Average } \mu\mu c\ Sr^{90}/kg \text{ of wheat}}$	$\dfrac{231}{62}=3.73$	$\dfrac{163}{47}=3.47$
$\dfrac{\text{Average } \mu\mu c\ Sr^{90}/kg \text{ of patent flour}}{\text{Average } \mu\mu c\ Sr^{90}/kg \text{ of wheat}}$	$\dfrac{12}{62}=0.19$	$\dfrac{9}{47}=0.19$

[1] Production weighted average of 9 States.

[2] Production weighted average of 5 States.

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[1] The data in table 1 are graphically presented in fig. 4 so that they may be easily compared with the 1958 results included in *Radiological Health Data*, Vol. I, No. 8, pp. 68–69.

[2] *Quarterly Summary Report*, HASL 84, dated Apr. 1, 1960, and presented graphically in *Radiological Health Data*, Vol. 1, No. 8.

[3] The 15 States represented in the 1959 sampling had a combined production of 78 percent of the total U.S. wheat production in 1958. The nine States sampled in 1958 had a combined production of 64 percent of the total 1958 U.S. wheat production. *The World Almanac*, 1960.

[4] U.S. Atomic Energy Commission Report, HASL–88, Sept. 8, 1960.

These data indicate that it may be possible to predict the strontium 90 concentration of bran and flour once an analysis of the wheat, from which these products are milled, has been made.

TABLE 1.—1959 WHEAT AND MILLING PRODUCTS

State	Section of State	Description	Calcium	Strontium 90	
			gm/kg orig. material	μμc/gm Ca	μμc/kg orig. material
Oklahoma	Mixture	Wheat, hard red winter	0.40	158	63
		Bran	1.35	168	227
		Germ	.78	148	115
		Shorts	1.09	157	171
		Flour, long clear	.37	99	37
		Flour, patent	.13	95	12
Montana	do	Wheat, hard red spring	.35	83	29
		Bran	1.06	66	70
		Germ	.64	81	52
		Shorts	1.08	63	68
		Flour, 1st clear	.23	30	7
		Flour, patent			
North Dakota	do	Wheat, hard red spring	.38	164	61
		Bran	1.03	126	130
		Germ	.63	145	91
		Shorts	1.10	124	137
		Flour, 1st clear	.20	65	13
		Flour, patent	.14	39	5
Michigan	do	Wheat, soft white	.38	125	48
		Bran	1.02	110	112
		Germ	.52	302	158
		Shorts	.90	40	36
		Flour, clear	.28	40	11
		Flour, patent	.17	36	6
Kansas	do	Wheat, hard red winter	.49	97	47
		Bran	1.41	132	186
		Germ	.73	124	90
		Shorts	1.18	101	119
		Flour, clear	.28	53	15
		Flour, patent	.20	44	9
Illinois	do	Wheat, soft red winter	.58	142	84
New York	do	Wheat, soft white	.37	119	44
Minnesota	do	Wheat, hard red spring	.33	122	40
Do.	Central	do	.33	210	69
Texas	Mixture	do	.51	99	51

TABLE 2.—STRONTIUM-90 MATERIAL BALANCE IN U.S. WHEAT MILLING PRODUCTS

Wheat fraction	Weight in kg	Strontium 90			
		1958 [1]		1959 [2]	
		μμc/kg	μμc in fraction	μμc/kg	μμc in fraction
Input: Whole wheat	100	62	6,200	[3] 53	[3] 5,300
Output:					
Patent flour	58	12	696	9	522
1st and 2d clear	14	28	392	17	238
Germ and shorts	17	133	2,261	143	2,431
Bran	11	231	2,541	163	1,793
Output total	100		5,890		4,984
Difference (input-output)			310		316
Percent difference			5.0		6.0

[1] Production weighted average of 9 States.
[2] Production weighted average of 5 States.
[3] Production weighted average of 15 States.

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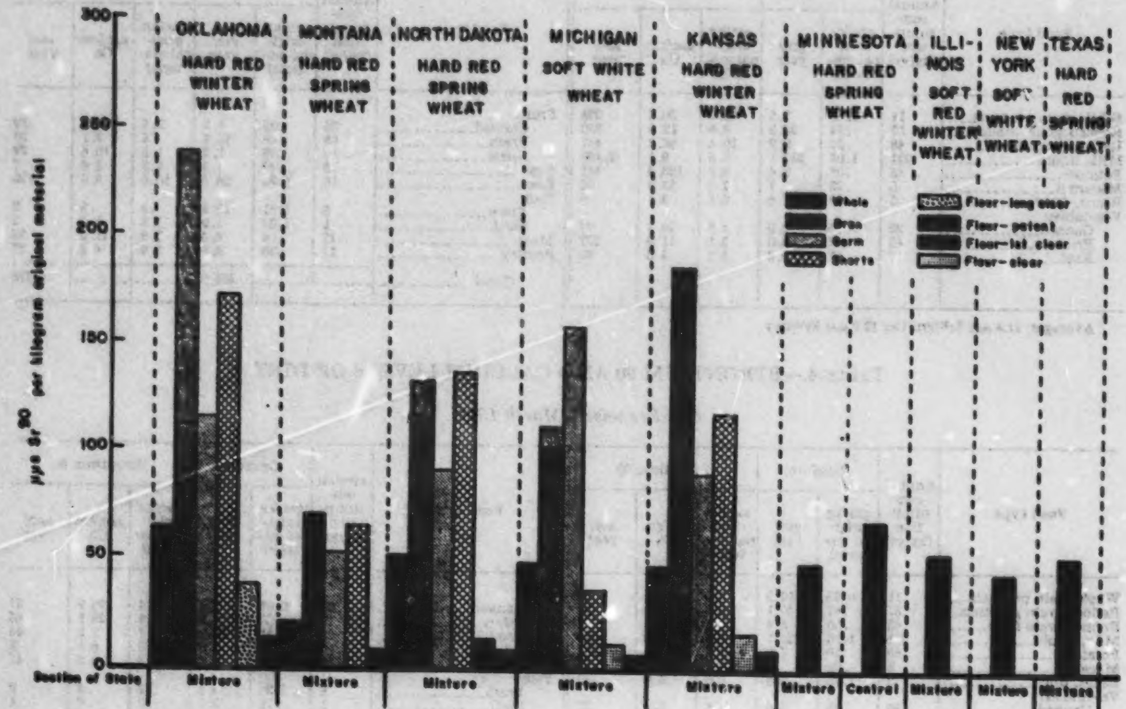
FIGURE 4.—STRONTIUM 90 IN 1959 WHEAT AND MILLING PRODUCTS



Tri-City Diet Study

Health and Safety Laboratory, U.S. Atomic Energy Commission

The Health and Safety Laboratory is conducting a survey of the strontium 90 and stable calcium levels of diets of persons living in New York City, San Francisco, and Chicago. Selected foods representing 19 food categories are purchased at each of these cities every 3 months and are analyzed for strontium 90 and stable calcium.

Using data from the U.S. Department of Agriculture "Household Food Survey" of 1955, the annual food consumption by an individual can be grouped into the same 19 categories, and the annual intake of strontium 90 and calcium can then be determined by summing the contributions from each category. Some food types are taken to be representative of larger food categories, as liquid milk for dairy products in general. Hence, in the tables that follow, the values shown for food consumption may not be directly related to the original data in the source document.

Tables 3, 4, and 5 show the results obtained for the three cities on the first completed set of analyses.[5]

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[5] Data from *Quarterly Summary Report*, HASL-105, Jan. 9, 1961.

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TABLE 3.—STRONTIUM 90 AND CALCIUM LEVELS OF DIET

New York City, March 1960

Food type	Annual consumption (kg/yr)	Calcium		Strontium 90		
		gm/kg original material	gm/year	µµc/kg original material	µµc/gm Ca	µµc/year
Whole grain products	11	0.69	7.6	20.7	30.4	228
Refined grain products	37	.75	27.3	9.6	12.9	359
Refined grain flour	43	.21	9.2	10.4	48.6	447
Milk, liquid	221	1.05	232.1	9.6	9.1	2,120
Potatoes	45	.08	3.4	9.8	129.3	441
Macaroni	3	.23	.7	7.3	31.5	22
Beans, dried	3	.53	1.6	2.1	3.6	6
Vegetables:						
Canned	20	.14	2.9	4.2	29.4	84
Fresh	43	.47	20.0	5.5	11.9	237
Root	17	.57	9.6	5.3	9.3	90
Fruit:						
Canned	25	.05	1.3	1.5	29.8	38
Fresh	65	.16	10.7	.3	2.1	20
Juices	19	.09	1.7	1.5	16.6	28
Rice	3	.40	1.2	2.3	5.6	7
Eggs	16	1.78	28.5	10.6	5.9	170
Fish:						
Fresh	8	1.61	12.9	.3	.2	3
Shell	1	1.34	1.9	1.8	1.3	2
Meat	72	.09	6.5	1.0	11.2	72
Poultry	17	.36	6.1	1.6	4.5	27
Total			385.2			4,375

Averages: 11.4 µµc Sr^{90}/gm Ca; 12.0 µµc Sr^{90}/day.

TABLE 4.—STRONTIUM 90 AND CALCIUM LEVELS OF DIET

San Francisco, March 1960

Food type	Annual consumption (kg/yr)	Calcium		Strontium 90		
		gm/kg original material	gm/year	µµc/kg original material	µµc/gm Ca	µµc/year
Whole grain products	11	0.93	10.2	2.0	2.1	22
Refined grain products	37	.81	30.1	1.8	2.2	66
Refined grain flour	43	.20	8.4	3.6	18.6	155
Milk, liquid	221	1.05	232.1	4.2	4.0	928
Potatoes	45	.16	7.0	4.4	28.2	198
Macaroni	3	.20	.6	3.7	18.6	11
Beans, dried	3	.93	2.8	6.3	6.6	19
Vegetables:						
Canned	20	.25	5.0	1.8	7.4	37
Fresh	43	.27	11.5	2.3	8.5	98
Root	17	.41	6.9	5.8	14.2	98
Fruit:						
Canned	25	0.06	1.4	1.4	25.9	37
Juices	19	.08	1.6	2.4	28.1	45
Fresh	65	.31	20.3	.7	2.3	46
Rice	3	.30	.8	1.8	6.1	5
Eggs	16	.65	10.4	2.9	4.5	47
Fish:						
Fresh	8	1.24	9.9	.2	.2	2
Shell	1	.79	1.1	.5	.6	1
Meat	72	.14	10.1	1.9	14.4	137
Poultry	17	.32	5.4	.7	2.3	12
Total			376.1			2,006

Averages: 5.3 µµc Sr^{90}/gm Ca; 5.5 µµc Sr^{90}/day.

TABLE 5.—STRONTIUM 90 AND CALCIUM LEVELS OF DIET

Chicago, May 1960

Food type	Annual consumption (kg/yr)	Calcium		Strontium 90		
		gm/kg original material	gm/year	µµc/kg original material	µµc/gm Ca	µµc/year
Whole grain products	11	0.85	9.4	19.9	23.4	219
Refined grain products	37	.92	34.0	12.1	14.2	483
Refined grain flour	43	.20	8.6	11.3	56.2	486
Milk, liquid	221	.98	215.8	6.1	6.2	1,348
Potatoes	45	.14	6.2	2.9	21.2	131
Macaroni	3	.22	.7	9.8	42.7	30
Beans, dried	3	1.45	4.4	1.8	12.0	5
Vegetables:						
Canned	20	.20	4.0	4.7	23.5	94
Fresh	43	.36	15.5	11.1	31.0	474
Root	17	.38	6.5	6.8	17.8	116
Fruit:						
Canned	25	0.05	1.3	1.9	38.2	49
Juices	19	.08	1.5	3.5	44.8	67
Fresh	65	.21	14.3	6.0	27.6	395
Rice	3	.19	.6	1.8	9.5	5
Eggs	16	.54	8.6	3.2	5.9	51
Fish:						
Fresh	8	1.55	12.4	1.0	.6	8
Shell	1	.50	.5	.7	1.5	1
Meat	72	.09	6.5	1.0	11.9	72
Poultry	17	.70	12.4	1.3	1.6	22
Total			367.3			4,073

Averages: 11.1 µµc Sr^{90}/gm Ca; 11.1 µµc Sr^{90}/day.

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Strontium 90 Concentration in Bread Purchased in New York City

Health and Safety Laboratory, U.S. Atomic Energy Commission

The following table presents data on the concentration of strontium 90 in bread purchased in New York City in July 1960. One loaf of each type was purchased daily from a local grocery and the loaves composited on a monthly basis. Five different brands are represented in each month's sample. Previous results were reported in *Radiological Health Data*, Volume I, Nos. 7 and 9.

TABLE 6.—STRONTIUM 90 AND CALCIUM IN BREAD PURCHASED IN NEW YORK CITY,[1] JULY 1960

Type of Bread	Calcium	Strontium 90		
	gm/kg of original material	μμc/gm Ca	μμc/kg of original material	μμc/daily intake[2]
Wholewheat	0.82	33	27	0.20
White	.85	15	13	.65

[1] Data taken from *Quarterly Summary Report*, HASL-105, Jan 9, 1961.
[2] Calculated values from U.S. Department of Agriculture data on average daily per capita consumption of 3.6 gm/day of wholewheat bread and 48.3 gm/day of white bread (see *Radiological Health Data*, Vol. I, No. 6).

Strontium 90 Concentration in Breakfast Cereals Purchased in New York City

Health and Safety Laboratory, U.S. Atomic Energy Commission

The following table shows the results of analyses of breakfast cereals containing wheat or bran, purchased in New York City during April 1960. These data may be compared with the results obtained by the Public Health Service's Robert A. Taft Sanitary Engineering Center for cereal purchased in Cincinnati, Ohio, April 1960. These were published in *Radiological Health Data*, Volume 1, No. 4.

TABLE 7.—STRONTIUM 90 CONCENTRATION IN BREAKFAST CEREALS[1]

New York City, April 1960

Type of cereal	Brand	Strontium 90	
		μμc/gm calcium	μμc/kg
100 percent bran	1	106	95
	2	89	83
	3	85	81
40 percent bran	2	85	[illegible]
Wholewheat	1	73	[illegible]
	2	76	[illegible]
	4	62	[illegible]
	5	78	[illegible]
Wholewheat (enriched):			
Regular	5	60	31
Instant	5	41	21

[1] Reported in *Quarterly Summary Report*, HASL-105, Jan. 9, 1961.

Strontium 90 in Foreign Wheat Samples

Health and Safety Laboratory, U.S. Atomic Energy Commission

As part of the continuing effort of the Health and Safety Laboratory to document the extent and effects of worldwide fallout, samples of wheat grown in various countries have been obtained and analyzed for strontium 90 and calcium. The preliminary results of this investigation are reported in table 8.[1]

The variability in the strontium 90 content of wheat samples obtained from the same country is apparent. Because of this variability, it is difficult to assess the representativeness of a single sample or small group of samples from a given region, and generalizations from these data must therefore be regarded cautiously.

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[1] Data from *Quarterly Summary Report*, HASL-105, Jan. 9, 1961.

TABLE 8.—STRONTIUM 90 AND CALCIUM CONTENT OF FOREIGN WHEAT SAMPLES GROWN IN 1959

Region of origin	Number of samples	Approximate harvest period	Calcium				Strontium 90							
			g/kg original material				$\mu\mu c/g$ Ca				$\mu\mu c/kg$ original material			
			Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum
Argentina	14	November 1959–January 1960.	0.35	0.05	0.30	0.40	32	9	21	48	16	4	13	22
Australia	1	do.	.35				32				11			
France	3	June–August	.38	.05	.33	.43	55	15	39	85	20	5	12	32
Germany	1	July–August	.44				73				32			
Greece	3	Not known	.48	.05	.40	.53	79	19	60	98	38	6	30	40
Netherlands	1	do.	.36				122				44			
Russia	13	July–September	.47	.07	.41	.57	65	44	45	210	30	10	18	54

SECTION III.—MILK

Milk Monitoring Program

Division of Radiological Health, Public Health Service

The original Public Health Service milk monitoring program consisted of 12 sampling stations, of which 9 are still active. Raw milk is spot sampled at these stations. During 1960 a new sampling program of about 60 stations was established. Processed milk is sampled at these stations. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Ala., and the Southwestern Radiological Health Laboratory at Las Vegas, Nev., provide this service for the new program.

The purposes of the two sampling programs are not the same. The original network was established to develop sampling and radiochemical analytical proficiencies under conditions which would remain similar over a period of time in regard to the source of milk. During the operation of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary. The Public Health Service and the Department of Health, Education, and Welfare acted to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances, the newly designated stations are the same as those which were reported originally. The establishment of the new processed-milk area sampling stations does not preclude the need for further raw-milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the collecting system, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers many factors, including laboratory methodology and collecting methods. Until this study has been completed and additional experience has been gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data will normally follow about 4 months after collection of samples because of the time required for shipment, processing, decay product buildup, compilation of the data, clearance and publication procedures.

Raw-Milk Sampling Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment with respect to measuring the amount of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures to make them more suitable for larger scale programs.

The criteria on which the selection of the original sampling stations was based appeared in the discussion sections of all volume I issues of *Radiological Health Data.*

One-gallon raw-milk samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analysis. It is estimated that these samples represent 2,000-gallon lots. The concentration of iodine 131, barium 140, cesium 137, and naturally occurring potassium 40 are all currently being measured by gamma scintillation spectroscopy. Total radiostrontium and strontium 90 are determined following radiochemical separations. The amount of strontium 90 is calculated by measuring the buildup of the strontium 90 daughter decay product, yttrium 90 over a 2-week period. Measurements are made in a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter, with the strontium 89 calculated as the difference between this value and strontium 90. Stable calcium is also determined.

April through September 1960 issues of *Radiological Health Data* list references for technical descriptions of the methodology of analyses used.

November data for the raw-milk-sampling stations are presented in table 1.

Processed Milk Area Sampling Stations

The monitoring of milk has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. Each city has been selected to provide adequate coverage with respect to production areas and the consuming population. The emphases of this expanded sampling and radioassay program are—

1. Measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant; and
2. Providing one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving the milk production and milkshed area characteristics.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from one day's sales per month in a community which will be as representative of the total supply as can be achieved under practical conditions. The sample will be a composite of those plants supplying not less than 90 percent of the

TABLE 1.—RADIOACTIVITY IN MILK

Robert A. Taft Sanitary Engineering Center, Raw-Milk-Sampling Stations, November 1960

[Radioactivity in μμc/liter]

Area	Calcium (grams/liter)		Iodine 131		Strontium 89		Strontium 90		Barium 140		Cesium 137	
	November	Yearly average	November	Yearly average	November	Yearly average	November	Yearly average	November	Yearly average	November	Yearly average
Atlanta, Ga.	1.20	1.13	ND[1]	<20	ND	<5	12.5	14.8	ND	<10	20	40
Austin, Tex.	1.14	1.11	ND	<10	ND	<5	4.0	4.5	ND	<10	5	15
Chicago, Ill.	1.19	1.10	ND	<10	ND	<5	7.7	8.4	ND	<10	15	25
Cincinnati, Ohio	1.21	1.13	ND	<10	ND	<5	8.8	10.5	ND	<10	15	25
New York, N.Y.	1.20	1.09	ND	<10	ND	<5	9.0	9.5	ND	<10	20	35
Sacramento, Calif.	1.21	1.12	ND	<10	ND	<5	2.7	2.5	ND	<10	10	15
Salt Lake City, Utah	1.23	1.11	ND	<10	ND	<5	2.4	6.2	ND	<10	10	30
Spokane, Wash.	1.27	1.12	ND	<10	ND	<5	6.6	11.7	ND	<10	20	40
St. Louis, Mo.	1.27	1.21	ND	<10	ND	<5	12.7	12.7	ND	<10	25	30

[1] NC—No detectable activity.

city's milk supply. The contribution from each plant to the total sample is intended to be approximately proportional to volumes of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analysis to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 States generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the Western States.

At the present time radioassays for Sr^{89}, Sr^{90}, Cs^{137}, Ba^{140}, and I^{131} are being performed. To date, the latter two isotopes have been below present limits of detection. Other radionuclides of concern to public health agencies will be included for assay as necessary for complete monitoring of the milk supply.

November data from the two laboratories are presented in table 2.

TABLE 2.--RADIOACTIVITY IN MILK

Processed Milk Area Sampling Stations, November 1960

[Radioactivity in μμc/liter]

Area	Calcium (grams/liter)		Strontium 89		Strontium 90		Cesium 137	
	November	Average to date	November	Average to date	November	Average to date	November	Average to date
Albuquerque, N. Mex.	1.09	1.10	ND[1]	<5	4	4	10	8
Atlanta, Ga.	1.23	1.23	ND	<5	8	10	ND	<5
Austin, Tex.	1.25	1.16	ND	<5	1	2	ND	5
Baltimore, Md.	1.23	1.16	ND	<5	7	7	ND	<5
Boston, Mass.	1.19	1.19	ND	<5	11	12	8	15
Buffalo, N.Y.	1.16	1.16	ND	<5	6	7	ND	8
Burlington, Vt.	1.20	1.20	ND	<5	7	9	ND	10
Charleston, S.C.	1.27	1.20	ND	<5	8	10	ND	8
Charleston, W. Va.	1.21	1.17	ND	<5	7	9	ND	<5
Charlotte, N.C.	1.30	1.22	ND	<5	10	12	ND	8
Chattanooga, Tenn.	1.32	1.30	ND	<5	10	11	ND	<5
Chicago, Ill.	1.23	1.16	ND	<5	6	6	ND	<5
Cincinnati, Ohio	1.12	1.18	ND	<5	8	8	ND	<5
Cleveland, Ohio	1.25	1.15	ND	<5	7	8	ND	<5
Dallas, Tex.	1.07	1.20	ND	<5	4	6	ND	<5
Denver, Colo.	1.01	1.09	ND	<5	5	6	15	15
Detroit, Mich.	1.19	1.16	ND	<5	8	7	ND	<5
Des Moines, Iowa	1.00	1.04	ND	<5	8	8	10	15
Grand Rapids, Mich.	1.25	1.23	ND	<5	7	8	ND	<5
Hartford, Conn.	1.35	1.19	ND	<5	10	9	ND	10
Helena, Mont.	1.10	1.08	ND	<5	6	7	10	10
Honolulu, Hawaii	1.00	1.08	ND	<5	4	6	15	20
Idaho Falls, Idaho	1.08	1.00	ND	<5	5	6	25	20
Indianapolis, Ind.	1.33	1.20	ND	<5	6	6	ND	<5
Jackson, Miss.	1.40	1.30	ND	<5	10	11	ND	<5
Kansas City, Mo.	1.04	1.08	ND	<5	8	8	20	15
Laramie, Wyo.	1.08	1.06	ND	<5	5	6	15	8
Las Vegas, Nev.	1.08	1.05	ND	<5	2	3	ND	<5
Little Rock, Ark.	1.20	1.21	ND	<5	14	13	ND	<5
Louisville, Ky.	1.23	1.19	ND	<5	10	9	ND	<5
Manchester, N.H.	1.29	1.23	ND	<5	10	12	15	20
Memphis, Tenn.	1.31	1.26	ND	<5	8	11	ND	<5
Milwaukee, Wis.	1.30	1.15	ND	<5	7	8	ND	<5
Minneapolis, Minn.	1.07	1.08	ND	<5	7	8	8	<5
New Orleans, La.	1.30	1.26	ND	<5	10	14	ND	<5
New York, N.Y.	1.20	1.12	ND	<5	10	9	ND	8
Norfolk, Va.	1.28	1.19	ND	<5	8	9	ND	<5
Oklahoma City, Okla.	1.28	1.18	ND	<5	6	8	ND	<5
Omaha, Nebr.	1.03	1.04	ND	<5	7	7	10	8
Palmer, Alaska	1.03	1.07	ND	<5	8	7	8	15
Philadelphia, Pa.	1.23	1.16	ND	<5	6	8	ND	15
Phoenix, Ariz.	.96	1.00	ND	<5	4	4	20	20
Pittsburgh, Pa.	1.24	1.21	ND	<5	10	12	ND	15
Portland, Maine	1.06	1.13	ND	<5	9	11	ND	20
Portland, Oreg.	1.08	1.10	ND	<5	8	10	25	25
Providence, R.I.	1.28	1.18	ND	<5	9	12	ND	15
Sacramento, Calif.	1.07	1.04	ND	<5	3	3	8	<5
Salt Lake City, Utah	1.12	1.00	ND	<5	5	6	10	8
San Francisco, Calif.	1.13	1.10	ND	<5	3	4	15	15
San Juan, P.R.	1.18	1.15	ND	<5	4	6	ND	<5
Seattle, Wash.	1.03	1.07	ND	<5	6	8	25	20
Spokane, Wash.	1.13	1.07	ND	<5	7	7	20	25
St. George, Utah	1.00	1.08	ND	<5	5	5	10	8
St. Louis, Mo.	1.03	1.04	ND	<5	7	6	15	15
Syracuse, N.Y.	1.22	1.22	ND	<5	8	7	ND	10
Tampa, Fla.	1.30	1.26	ND	<5	5	5	20	20
Trenton, N.J.	1.19	1.18	ND	<5	10	6	ND	8
Washington, D.C.	1.30	1.14	ND	<5	11	8	ND	<5
Wichita, Kans.	1.19	1.07	ND	<5	8	6	5	<5
Wilmington, Del.	1.21	1.20	ND	<5	8	8	ND	10

[1] ND—No detectable activity.

Because this program was initiated in 1959 and sampling stations necessarily became operative in a staggered sequence, the averages shown represent all samples taken to date. Averages will normally be for the latest 12-month period after sampling began. For the November data, the averages cover a period of three to nine months.

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Strontium 90 in Canadian Dried-Milk Products

The following table presents the results of measurements of strontium 90 in Canadian dried milk for the months of July, August, and September, 1960. This table was included in the "Quarterly Report of the Radioactive Fallout Study Program," dated December 1960, published by the Radiation Protection Division of the Department of National Health and Welfare, Ottawa, Canada. Figure 5 shows the sampling locations.

Data for the previous months in 1960 were published in *Radiological Health Data*, volume 1, Nos. 6 and 9.

TABLE 3.—STRONTIUM 90 CONTENT OF CANADIAN DRIED MILK POWDER SAMPLES

[Concentrations in μμc/gm calcium]

Station	July 1960	August 1960	September 1960
Calgary	9.4	8.3	8.8
Charlottetown	[2] [illegible]	NS	NS
Chicoutimi	NS	13.3	10.4
East Florenceville	12.1	14.0	12.6
Edmonton [1]	12.4	7.8	7.6
Granby [1]	12.3	13.3	10.3
La Durantaye	13.9	11.3	10.2
London [1]	4.8	3.9	3.4
Megantic	17.0	18.7	12.6
Moncton [1] [2]	7.9	12.9	2.0
Ottawa [1]	5.5	3.7	3.3
Saskatoon [1]	8.8	6.4	5.5
Sussex	11.4	11.6	9.0
Vancouver [1]	11.9	6.7	9.0
Walkerton	4.7	3.4	3.8
Winnipeg [1]	6.7	5.8	6.3
Average	10.4	9.3	8.1

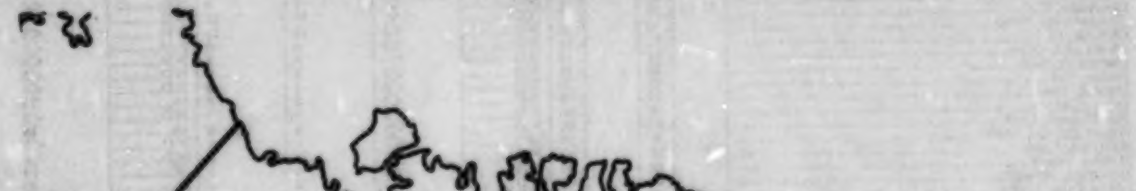
[1] Natural strontium determinations made for these stations. All other analyses were corrected for natural strontium using an average factor of 1.25.

[2] Buttermilk sample. All other samples are skim milk.

[3] NS—No milk powder manufactured for the month.

Samples collected by Inspectors of the Marketing Division, Department of Agriculture.

FIGURE 5.—MILK SAMPLING STATIONS IN CANADA



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SECTION IV.—WATER

National Water Quality Network

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network was established under the provision of section 4(c) of Public Law 660, which states "* * * The Surgeon General shall * * * collect and disseminate basic data * * * [relating] to water pollution and the prevention and control thereof."

This network, operated in cooperation with State and local health agencies, was started in October 1957. At present there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are on interstate, coastal, and international boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be in operation. A few of the more recently established stations have not begun to report radioactivity.

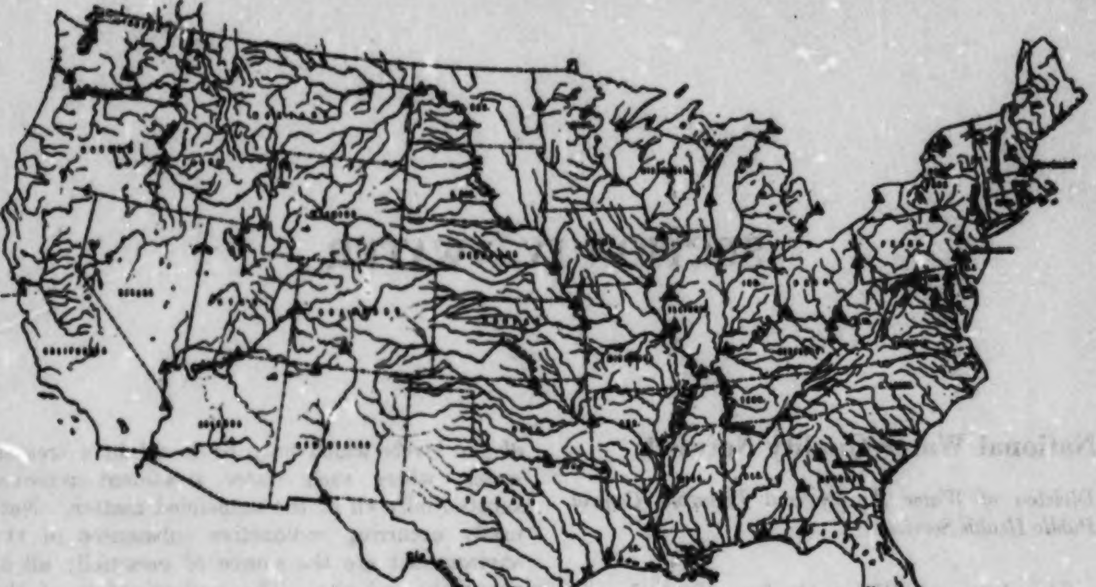
Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from manmade sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River. The results are reported in micromicrocuries per liter, and are shown for each station on a given river.

While beta determinations for the first 2 years of the network operation have been conducted on each sample weekly, the alpha determinations are reported generally on a composite sample of more than 1 week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on 3-month composite samples, with one-third of the stations being covered each month. All the data reported in table 1 represent the average of all information available for the month indicated.

Strontium 90 data reported are the results of determinations on composite samples for a 3-month period ending in the month shown.

FIGURE 6.—PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS



As of June 30, 1960

Additional information and data may be obtained from the following sources:

***National Water Quality Network Annual Compilation of Data*, PHS Publication. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price, $1.50.**

***Report on National Water Quality Control Network* submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy "Hearings on Fallout From Nuclear Weapons Tests," volume 1, May 1959, pages 167–169.**

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Concentrations in $\mu\mu c$/liter]

Station	Quarter ending Oct. 30, 1960	October 1960					
	Strontium 90	Beta activity			Alpha activity		
		Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River: Cedar Hill, N. Mex.	0.4	26	40	66	2	20	22
Apalachicola River: Chattahoochie, Fla.	.5	0	0	0	0	3	3
Arkansas River:							
Coolidge, Kans.	.8	0	0	0	3	63	66
Ponca City, Okla.		0	0	0	7	3	10
Pendleton Ferry, Ark.		1	20	21	7	2	9
Chattahoochie River:							
Atlanta, Ga.		0	3	3	0	1	1
Columbus, Ga.		0	0	0	0	1	1
Colorado River:							
Loma, Colo.		5	20	25	1	25	26
Page, Ariz.		114	2	116	55	23	78
Hoover Dam, Ariz.—Nev.	1.0	0	0	0	0	10	10
Parker Dam, Ariz.—Nev.		0	1	1	0	17	17
Yuma, Ariz.		0	3	3	<1	3	3
Columbia River:							
Pasco, Wash.		56	661	717	0	2	2
Wenatchee, Wash.		0	0	0	0	2	2
Bonneville Dam, Oreg.		11	262	273	0	2	2
Clatskanie, Oreg.	.3	8	140	148	0	1	1
Connecticut River: Northfield, Mass.		0	0	0	0	1	1

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Concentrations in μμc/liter]

Station	Quarter ending Oct. 30, 1960	October 1960					
	Strontium 90	Beta activity			Alpha activity		
		Suspended	Dissolved	Total	Suspended	Dissolved	Total
Delaware River:							
Martin's Creek, Pa.		0	1	1	0	1	1
Philadelphia, Pa.		0	0	0	2	0	2
Escambia River: Century, Fla.		0	0	0	0	1	1
Great Lakes:							
Gary, Ind.	0.5	0	4	4	0	3	3
Duluth, Minn.		0	0	0	0	1	1
Milwaukee, Wis.		0	0	0	0	<1	<1
Hudson River: Poughkeepsie, N.Y.	.1	0	2	2	0	2	2
Illinois River: Peoria, Ill.	.3	2	2	4	1	2	3
Kanawha River: Winfield Dam, W. Va.		5	3	8			
Little Miami River: Cincinnati, Ohio		2	0	2	0	4	4
Mississippi River:							
Williston, N.Dak.		0	7	7	3	9	12
Yankton, S.Dak.	.3	0	0	0	0	0	0
Omaha, Nebr.		0	27	27	2	7	9
St. Joseph, Mo.		28	<1	28	12	7	19
Kansas City, Kans.		1	0	1	2	5	7
St. Louis, Mo.	1.2	1	11	12	0	0	0
Ohio River:							
East Liverpool, Ohio	.4	0	0	0	0	0	0
Wheeling, W Va.	.5	0	<1	<1	0	2	2
Huntington, W. Va.		0	0	0	0	0	0
Cincinnati, Ohio		0	0	0	0	1	1
Evansville, Ind.		0	0	0	0	2	2
Cairo, Ill.	.4	2	26	28			
Potomac River: Great Falls, Md.		0	0	0	0	4	4
Red River, North: Grand Forks, N.Dak.	(1)	0	5	5	1	4	5
Red River, South:							
Denison, Tex.		0	0	0	0	11	11
Index, Ark.		0	0	0	12	7	19
Alexandria, La.	1.1	0	0	0	2	6	8
Rio Grande River:							
El Paso, Tex.		0	2	2	0	14	14
Brownsville, Tex.	.3	4	0	4	2	0	2
Sabin River: Ruliff, Tex.		2	2	4	1	1	2
St. Clair River: Port Huron Mich.	.6	<1	<1	1	0	1	1
St. Lawrence River: Massena, N.Y.		0	2	2	0	2	2
St. Mary's River: Sault Ste. Marie, Mich.		0	0	0	0	1	1
Schuylkill River: Philadelphia, Pa.		0	<1	<1	0	1	1
Savannah River:							
Port Wentworth, Ga.	.3	0	28	28			
North Augusta, S.C.		0	0	0	0	1	1
Snake River:							
Wawawai, Wash.	.5	0	0	0	0	4	4
Weiser, Idaho		5	20	25	0	7	7
Susquehanna River:							
Sayre, Pa.	.2	0	0	0	0	<1	<1
Conowingo, Md.	.3	0	<1	<1	<1	1	1
Tennessee River: Chattanooga, Tenn	.6	0	22	22	0	<3	<1
Yellowstone River: Sidney, Mont.		0	0	0	8	11	19

[1] Insufficient sample for analysis.

Strontium 90 in Tap Water

Health and Safety Laboratory, Atomic Energy Commission

The Atomic Energy Commission's Health and Safety Laboratory monitors the tap water for Richmond, Calif., and New York City for strontium 90 on a monthly basis. Data for the third quarter 1960 are presented below. Previous data for 1960 were given in *Radiological Health Data*, Volume I, Nos. 1, 5 and 9.

TABLE 2.—STRONTIUM 90 IN TAP WATER [1]

Third Quarter 1960

Location	Month	Activity (μμc/liter)
Richmond, Calif. (40 liters per sample)	July	0.265
	August	.253
	September	.267
New York City (100-200 liters per sample)	July	.51
	August	.46
	September	.47

[1] Data from *Quarterly Summary Report*, HASL-106, dated Jan.9, 1961.

SECTION V.—OTHER DATA

External Gamma Activity

Division of Radiological Health,
Radiation Surveillance Network, Public Health Service

Portable survey instruments are available at stations of the Radiation Surveillance Network for recording levels of external gamma radiation. Measurements are made daily approximately 3 feet above the ground. These readings are not precise, but are sufficiently accurate to illustrate any significant variations above background. The differences among the values shown in the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY
November 1960

Station location	Average (mr/hr)	Station location	Average (mr/hr)	Station location	Average (mr/hr
Anchorage, Alaska	0.01	Iowa City, Iowa	0.02	Ponca City, Okla	0.04
Fairbanks Alaska	(1)	Topeka, Kans	(1)	Portland Oreg	.02
Juneau, Alaska	.01	New Orleans, La	.01	Harrisburg, Pa	.01
Phoenix, Ariz	.01	Baltimore, Md	.02	Providence R.I	.02
Little Rock, Ark	.01	Lawrence, Mass	.03	Columbia, S.C	.02
Berkeley, Calif	.01	Lansing, Mich	.02	Edgemont, S. Dak	(1)
Los Angeles, Calif	.01	Minneapolis, Minn	.01	Pierre, S. Dak	.02
Denver, Colo	.03	Pascagoula, Miss	(2)	Austin, Tex	.01
Hartford, Conn	.01	Jefferson City, Mo	.01	El Paso, Tex	.02
District of Columbia	.02	Helena, Mont	.03	Salt Lake City, Utah	.02
Jacksonville, Fla	.02	Trenton, N.J	(2)	Richmond, Va	.01
Atlanta, Ga	.02	Santa Fe, N. Mex	.04	Seattle, Wash	.02
Honolulu, Hawaii	.03	Albany, N.Y	.02	Cheyenne Wyo	.03
Boise, Idaho	.02	Gastonia, N.C	.02	Madison, Wis	.02
Springfield, Ill	(1)	Cincinnati, Ohio	(1)		
Indianapolis, Ind	.01	Oklahoma City, Okla	.02		

[1] No data received. [2] Instrument failure.

Cesium 137 Levels in Humans

Walter Reed Army Institute of Research, Washington, D.C., and U.S. Army Medical Research Unit, Landstuhl, Germany

Since July 1958, the Whole Body Counting Facility at the Walter Reed Army Institute of Research has been assaying people and foodstuffs for gamma radioactivity. A detailed report of the facility, describing the construction, functional characteristics of the instruments, methods of radioassay, and results for the period July 1, 1958, to July 1, 1960, has been submitted to the Defense Atomic Support Agency (DASA).

The 4 pi liquid scintillation counter employed by the Walter Reed Army Institute of Research is essentially a horizontal well counter and is similar in design to that used at the Los Almos Scientific Laboratory.

The horizontal detector tank which surrounds the detector well (except at the ends) is 6 feet long, has an inner diameter of 32 inches, and can accommodate approximately 144 gallons of scintillation solution 4 grams per liter p-terphenyl plus 0.1 gram per liter POPOP (1,4-bis-[2-(5-phenyloxazolyl)]-benzene) in reagent grade toluene. The loading trough is a horizontal stainless-steel half-cylinder approximately 8 feet long with a radius of about 10 inches. A cylindrical shield (class B armor) surrounds the detector, providing 5¾ inches of shielding.

Mounted radially through the outer wall and looking into the detector tank are six rows of five-inch photomultiplier tubes with five tubes in each row. These thirty 5-inch photomultiplier tubes provide an approximate 5.8 percent photocathode coverage of the area presented by the scintillation solution and are wired in 2 banks of 15 tubes each.

Two coincidence units are used. Channel I accepts pulses which represent photon energies of 0.3 to 0.8 Mev, and channel II, 0.9 to 2.0 Mev.

The procedures used to obtain counting efficiencies for Cs^{137} and K^{40} have been (1) the assembly of diffuse homogeneous sources of varying mass from 2.5-liter plastic bottles containing small quantities of the radioelement under study; (2) the use of a plastic manikin (Remcal, Alderson Research Laboratories); and (3) the determination of the counting efficiency for K^{42} in the normal human subject at some time after equilibrium distribution.

The Whole Body Counting Facility of the U.S. Army Medical Research Unit in Landstuhl, Germany, has been assaying people since June 1959. This vertical, 2 pi, "walk-in" counter was originally designed for exhibit at the Second Geneva Conference on the Peaceful Uses of Atomic Energy. Subsequently, it was dismantled and reassembled at Landstuhl.

The Geneva counter[1] is far more simply constructed than its predecessor, the Los Alamos counter (for example, in the Geneva counter, the subject merely walks into the counting chamber). The counting "well" in which the subject stands is one-half of an 18-inch-diameter cylinder. The counter accommodates 280 liters of scintillation solution (terphenyl and POPOP in triethylbenzene), is equipped with 10 tons of lead shielding, and uses six 16-inch photomultiplier tubes which cover 13 percent of the wall area.

The Landstuhl data are listed by month and are tabulated in the upper part of table 2. The Walter Reed data are listed by quarters and geographic area and in tables 2, 3, and 4.

Table 4 has been based on the following calculations:

1. An average for the third and fourth quarters of 1960 was calculated by weighting the average values of cesium 137 per gram of potassium with the number of subjects in each quarter respectively. These values were extracted from tables 1 and 2.

2. The weighted average was multiplied by the average total quantity of potassium in the human body, 150 grams,[2] thus yielding the total cesium 137 content of a "standard man".

3. A "percent MPC" was calculated by comparing the total cesium 137 content of this "standard man" to one-tenth the maximum permissible burden in the human body for cesium 137;[3] i.e.,

TABLE 2.—TABULATED RESULTS FROM BOTH FACILITIES

Date (inclusive when applicable)	Subjects residing in—	Number of subjects	$\mu\mu c$ Cs^{137}/gm K (average)
U.S. Army Medical Research Unit:			
July 1960	West Germany	393	62
August 1960	do	377	65
September 1960	do	313	71
October 1960	do	410	62
November 1960	do	174	53
Walter Reed Army Institute of Research:			
July 1958–June 1959	United States	905	60
July 1959–June 1960	do	744	62
July–September 1960	do	147	46
October–December 1960	do	104	46

TABLE 3.—ASSAYS PERFORMED AT THE WALTER REED ARMY INSTITUTE OF RESEARCH, WASHINGTON, D.C.

Geographic area	3d quarter 1960		4th quarter 1960	
	Number of subjects	$\mu\mu c$ Cs^{137}/gm K (average)	Number of subjects	$\mu\mu c$ Cs^{137}/gm K (average)
Africa	1	65		
Asia	1	52	1	32
Canada			1	53
Caribbean			2	54
Central America	1	38	2	59
Europe	36	66	60	65
Far East	27	44	38	42
Greenland-Iceland	1	45		
Near East	1	33	2	62
Pacific islands			5	43
United States	147	46	104	46

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[1] Anderson, E. C., Hays, F. N., Hiebert, R. D., "Walk-in Human Counter," *Nucleonics, 16*: 8, p. 106, August 1958.

[2] Shohl, A. T., "Mineral Metabolism," Reinhold Publishing Co., New York, 1939.

[3] NBS HB-69, "Maximum Permissible Body Burdens and Permissible Concentrations of Radionuclides in Air and Water for Occupational exposure," June 1959.

it was compared to a value representing the maximum body burden for a member of the general population.

Future reports from both facilities will be presented quarterly in *Radiological Health Data*.

TABLE 4.—ASSAYS OF INDIVIDUALS RESIDING WITHIN THE UNITED STATES

Performed at Walter Reed Army Institute of Research, Washington, D.C.

State	3d quarter 1960		4th quarter 1960	
	Number of subjects	$\mu\mu c$ Cs^{137}/gm K (average)	Number of subjects	$\mu\mu c$ Cs^{137}/gm K (average)
Alabama	2	36	3	36
Alaska	2	55	4	49
Arizona			1	50
California	6	35	6	51
Colorado	3	47		
Connecticut	1	42	3	60
Delaware	1	38		
District of Columbia	45	46	24	55
Florida	1	64	3	38
Georgia	2	52	2	44
Hawaii	5	55	1	62
Maine			1	43
Illinois	3	45	9	50
Indiana	1	50	1	54
Kansas	3	40	1	43
Kentucky	1	30	6	59
Louisiana	3	35	3	53
Maryland	5	54	4	50
Massachusetts	1	52	3	56
Michigan	4	51	4	64
Missouri			8	38
Nevada			1	57
New Jersey	2	70	5	69
New Mexico			1	14
New York	10	51	17	52
North Carolina	1	61	6	53
North Dakota	1	47	1	56
Ohio	6	42	5	40
Oklahoma	1	34		
Oregon	2	47		
Pennsylvania	4	51	7	36
Rhode Island			1	52
South Carolina	1	30	9	43
South Dakota	1	47		
Tennessee	1	35	1	64
Texas	11	34	10	32
Utah	1	48		
Virginia	7	58	2	56
Washington	1	34	3	30
West Virginia	1	50	1	55
Wisconsin	2	46	2	51

TABLE 5.—PARTIAL SUMMARY OF TABLES 2 AND 3

Country	3d quarter		4th quarter		Weighted average	Percent MPC
	Number of subjects	$\mu\mu c$ Cs^{137}/gm K (average)	Number of subjects	$\mu\mu c$ Cs^{137}/gm K (average)		
Africa	1	66			66	0.33
Asia	1	22	1	33	28	.17
Canada			1	55	55	.28
Caribbean			2	54	54	.27
Central America	1	58	2	60	60	.30
Europe	36	66	40	65	66	.33
Far East	27	44	35	42	43	.22
Greenland-Iceland	1	45			45	.23
Near East	1	33	2	62	52	.26
Pacific islands			5	43	43	.22
West Germany	962	64	584	[1] 59	62	.31
United States	147	45	164	46	46	.23

[1] Values represent determinations for October through November 1960.

Body Burden of Radioisotopes in People Residing in the San Juan Basin

Division of Radiological Health, Public Health Service

A study of body burdens of radioisotopes in the population of the San Juan Basin area has been initiated by the Public Health Service at the request of the State health officers of Colorado and New Mexico. The study seeks answers to the following general questions:

1. Is the body burden a reliable and true index to clinical states that may be encountered?
2. Are safety factors which have been introduced in the radiation exposure guides realistic?

Specific objectives which will serve as a basis for answering these questions are:

1. Determination of body burden in a population which has resided for 10 years in an area served by a water supply periodically analyzed for radioactivity. This includes determining the body burden existing at the time of an initial examination, and the relative buildup in relation to concurrent amounts of radionuclides ingested in the normal diet and in excreta.
2. Devising of practical methods for determining the buildup of the radium body burden in a population, particularly the children of a study area.

The San Juan Basin population was chosen for this special study because of its exposure to radioactivity from drinking water containing radium in amounts higher than those found in most areas in the United States.

In order to relate measurements of concentrations of radium and strontium in food and water to health hazards, it is essential to know the actual physical dose absorbed by persons ingesting the contaminated food and water. Theoretical calculations of the physical dose based on measured concentrations in food and water are not sufficiently reliable to warrant their exclusive use. Thus, in addition to measuring intake and concentrations in food and water, an attempt will be made to measure the total amount of radionuclides present in the bodies of persons living in this area. In this fashion it is hoped that body burdens can be related to the basic standard of physical dose and that theoretical calculations can be compared to actual experimental measurements.

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In order to determine a population displaying appropriate characteristics, a special census was taken by the 1960 census enumerators under contract with the New Mexico Department of Public Health. The purpose was to determine families meeting the over 10 years' residence criterion. It is proposed to select at random 100 families (about 400 persons) from those meeting the residence criterion. For this sample a complete analysis of intake of radioactive substances via food and water will be carried out. Concurrently, the excretion rates of radium and strontium will be measured in feces, urine, and breath. In addition, human and animal bone samples will be collected for analysis.

A study also will be made of the buildup of body burdens of children, immigrants, and newborns in the area.

Environmental assessment, in order to describe the complete radiological health situation in the area of study, will include collection and analyses of samples of potable and raw water, soil, vegetation, and human food supplies. Information from this source will be correlated with data obtained from a total assessment of radiation exposure of all origins: diagnostic, therapeutic, external environmental, and occupational.

Vital statistics of the area will be studied to discern any unusual patterns of morbidity or mortality which may exist. Following an analysis of these data, a complete prospective epidemiological and clinical investigation of those families in the area meeting the requirement of long-term residency may be undertaken.

It is estimated that this study will require a minimum of 5 years, with a 15-year span being considered desirable to develop valid results.

This study is being conducted as a cooperative venture of the Public Health Service and the New Mexico Department of Public Health. An on-site limited laboratory facility has been staffed and equipped in Farmington, N. Mex., for the purpose of processing the biological samples obtained. It is planned that detailed radioactivity analyses will be conducted by Public Health Service laboratories at other locations. Radon breath analysis equipment has been ordered and is expected to be operational on-site by July 1961. Methodology for collecting and processing samples has been devised and is undergoing testing. A pilot study of a few of the selected 100 families has begun. As the data become available, they will be published in future issues of *Radiological Health Data*.

Strontium 90 Content of Human Bone and Teeth

Health and Safety Laboratory, U.S. Atomic Energy Commission

The Health and Safety Laboratory has been obtaining samples of bone from children who died in New York City since 1957. These samples are taken only from the bodies of children whose nutrition and calcium metabolism can be presumed to have been normal prior to death.

Late in 1959 an effort was made to obtain teeth as well as bone samples from the same cadaver to see if a relation could be established between the Sr^{90}/Ca ratio of primary teeth and the skeletal strontium 90 burden.

The results obtained thus far in this continuing program are presented in table 6.[4]

TABLE 6.—STRONTIUM 90 IN HUMAN BONE AND TEETH

Date of death	Age (years)	Sex	Type samples	Number specimens	Calcium	Strontium 90	
					mg/gm original material	μμc/gm original material	μμc/gm Ca
1957:							
September	6½	F	Bone				1.38
September	6¾	M	Bone				.98
1958:							
September	5	M	Sternum, rib				
			Vertebrae, skull				.88
December	5	F	Bone				1.01
September	7	M	Bone				1.16
June	8	M	Vertebrae				1.27
September	10	F	Rib, vertebrae				1.09
September	11	M	Sternum, rib				
			Vertebrae, skull				.69
1959:							
January	2	M	Spine				1.80
January	3	M	Rib				1.75
September	4	M	Teeth	6	242	0.51	2.12
November	4½	F	Teeth	5	264	.76	2.86
September	7	M	Teeth	8	253	.16	.64
September	8	M	Teeth	6	247	.10	.40
September	10	M	Teeth	8	253	.07	.37
1960:							
January	3½	F	Rib		48	.14	2.83
			Vertebrae		37	.11	2.98
			Teeth		198	.40	2.02
March	4	F	Femur		184	.60	3.30
			Rib		93	.20	2.10
			Teeth	7	284	.54	1.91

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[4] Data from *Quarterly Summary Report*, HASL–105, Jan. 9, 1961.

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ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission is providing data on environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis. The data are from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Radiological Health Data, Volume I, Nos. 8 and 9, and Volume II, Nos. 1, 2, and 3, contain summaries for 16 installations. Summaries follow for Argonne National Laboratory, covering the second quarter of 1960, and the Feed Materials Production Center, covering 1959 and the first two quarters of 1960.

Argonne National Laboratory

University of Chicago, Lemont, Ill., Issued December 20, 1960

Environmental levels of radioactivity at Argonne National Laboratory (ANL) for 1959 and first quarter 1960 were reported in *Radiological Health Data*, Volume I, No. 9. The following report presents a summary of the data for the second quarter of 1960.

The radioactivity in the environment is determined by measuring concentrations of radioactivity in naturally occurring materials collected on the ANL site and to a distance of 100 miles from the site. Since air and water are the most probable media for disseminating radioactivity, the environmental monitoring program at ANL has concentrated on these materials. The air- and water-sampling locations discussed in this report are shown in figures 7 and 8.

Figure 7 is a map of the ANL site which has been divided into 1,000-foot squares by a series of grid lines. Sampling points on the site are identified by specifying the square in which they are located. For example, the Sawmill Creek sampling locations are in squares 13L and 7M. Sampling locations off the site (fig. 8) are identified by their geographical location.

Samples are first analyzed for their total alpha and total beta radioactivity. These analyses provide a rapid means of assessing the general radioactive level of the samples and indicate whether the samples contain normal or above-normal amounts of radioactivity. Some of the samples are then analyzed for specific isotopes that are likely to be responsible for the alpha and beta activities observed.

Radioactivity in Surface Water

ANL waste water is analyzed for radioactive content prior to discharge into Sawmill Creek, a small stream that runs through the ANL grounds and empties into the Des Plaines River about 500 yards downstream from the waste water outfall. Sawmill Creek was sampled upstream from the ANL site and downstream from the waste water outfall to determine if any radioactivity was added to the creek by ANL waste water. The uranium and total alpha activity found in

FIGURE 7.—SAMPLING LOCATIONS, ARGONNE NATIONAL LABORATORY

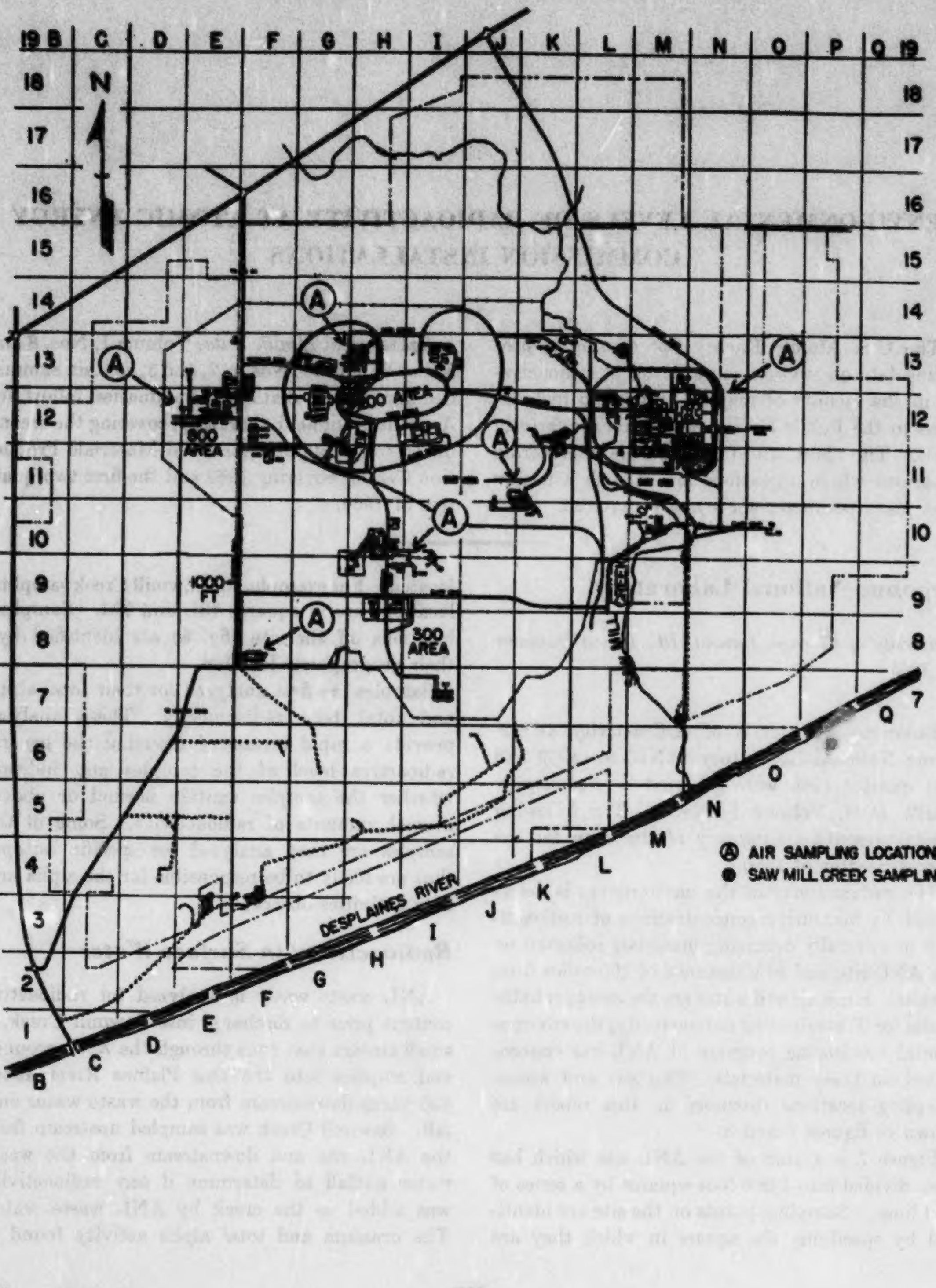
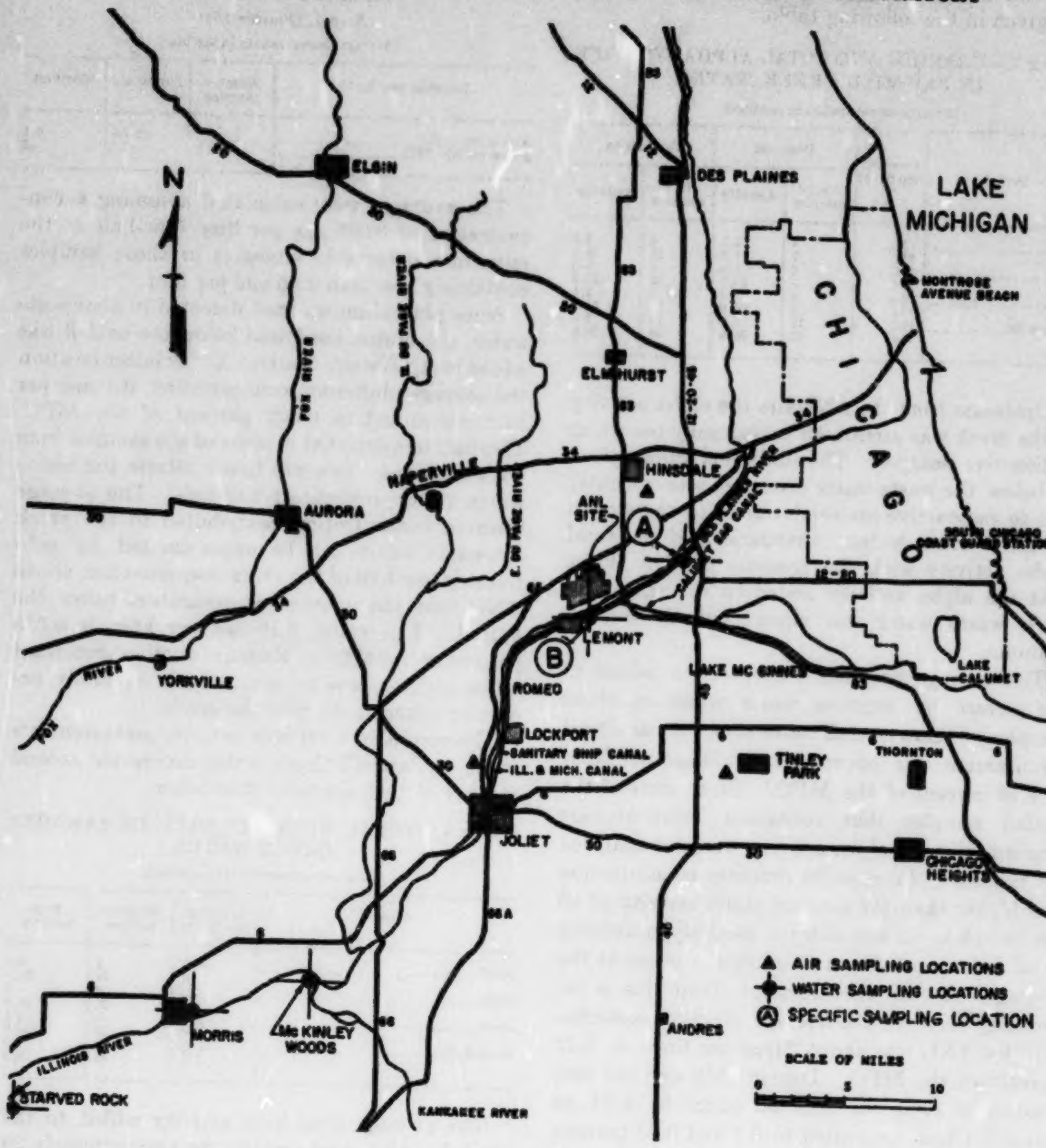

19 B C D E F G H I J K L M N O P Q 19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
N
800 AREA
200 AREA
300 AREA
1000 FT
SAW MILL CREEK
DESPLAINES RIVER
B C D E F G H I J K L M N O P Q
Ⓐ AIR SAMPLING LOCATIONS
● SAW MILL CREEK SAMPLING

FIGURE 8.—OFF-SITE SAMPLING LOCATIONS, ARGONNE NATIONAL LABORATORY


N
LAKE MICHIGAN
CHICAGO
ELGIN
DES PLAINES
MONTROSE AVENUE BEACH
ELMHURST
HINSDALE
NAPERVILLE
AURORA
ANL SITE
A
SOUTH CHICAGO COAST GUARD STATION
LEMONT
B
ROMEO
YORKVILLE
FOX RIVER
LAKE MC GINNIES
LAKE CALUMET
LOCKPORT
SANITARY SHIP CANAL
ILL. & MICH. CANAL
TINLEY PARK
THORNTON
JOLIET
CHICAGO HEIGHTS
MORRIS
Mc KINLEY WOODS
ILLINOIS RIVER
STARVED ROCK
KANKAKEE RIVER
ANDRES
W. DU PAGE RIVER
E. DU PAGE RIVER
DES PLAINES RIVER
CAL-SAG CHANNEL
▲ AIR SAMPLING LOCATIONS
✦ WATER SAMPLING LOCATIONS
Ⓐ SPECIFIC SAMPLING LOCATION
SCALE OF MILES
0 5 10

Sawmill Creek during the second quarter of 1960 are given in the following table.

TABLE 7.—URANIUM AND TOTAL ALPHA ACTIVITY IN SAWMILL CREEK WATER

[Average concentration in $\mu\mu c$/liter]

Period	Location (see fig. 1)	Uranium		Total alpha	
		No. of samples	Activity	No. of samples	Activity
April	13L	4	1.1	4	2.3
	7M	7	14.5	13	16.1
May	13L	4	1.4	4	1.5
	7M	8	32.1	12	22.3
June	13L	5	1.4	5	2.1
	7M	7	63.9	13	35.3
2d quarter	13L	13	1.3	13	2.0
	7M	22	36.6	38	24.6

Upstream from the ANL site the alpha activity in the creek was attributed to naturally occurring radioactive isotopes. The additional alpha activity below the waste-water discharge was evidently due to radioactive materials added to the stream by ANL waste water. Comparison of the total alpha activity with the uranium content shows that the alpha activity added to the stream in ANL waste water was almost entirely due to uranium.

The average uranium concentration added to the stream by Argonne waste water in those samples of below-outfall water that were analyzed for uranium was approximately 36$\mu\mu c$ per liter, or 0.18 percent of the MPC.[1] Since some of the outfall samples that contained below-average amounts of total alpha activity were not analyzed for uranium, the average uranium concentration was higher than the average alpha activity of all the samples. If the average total alpha activity in all below-outfall water samples is taken as the average uranium concentration (and this is essentially correct), the average uranium contribution by ANL was about 24$\mu\mu c$ per liter, or 0.12 percent of the MPC. During 1959 and the first quarter of 1960, the uranium added by ANL to Sawmill Creek amounted to 0.1 and 0.63 percent of the MPC, respectively. Small amounts of plutonium and thorium contributed by ANL waste water were also found in Sawmill Creek below the waste-water outfall. The alpha activities due to these elements are summarized in the table below.

TABLE 8.—PLUTONIUM AND THORIUM IN SAWMILL CREEK WATER

Second Quarter 1960

[Average concentrations in $\mu\mu c$/liter]

Location (see fig. 1)	Number samples	Plutonium	Thorium
Above site (13L)	6	<0.05	0.1
Below outfall (7M)	13	.1	.3

The averages were calculated assuming a concentration of 0.025 $\mu\mu c$ per liter (one-half of the minimum detectable amount) in those samples containing less than 0.05 $\mu\mu c$ per liter.

Since plutonium was not detected in above-site water, the plutonium found below the outfall was added in ANL waste water. At the latter location the average plutonium concentration, 0.1 $\mu\mu c$ per liter, amounted to 0.002 percent of the MPC. Thorium was detected in some of the samples from both locations. Sawmill Creek dilutes the waste water by approximately one-half. The average thorium concentration contributed to the creek by waste water can be approximated by subtracting one-half of the creek concentration above ANL from the average concentration below the outfall. This value, 0.25 $\mu\mu c$ per liter, is 0.013 percent of the MPC. Radium, another important alpha emitter, was present only in naturally occurring concentrations in the creek.

The results of total beta activity measurements made on Sawmill Creek water during the second quarter of 1960 are tabulated below.

TABLE 9.—TOTAL BETA ACTIVITY IN SAWMILL CREEK WATER

[Average concentration in $\mu\mu c$/liter]

Month	Location (see fig. 1)	Number samples	Beta activity
April	13L	4	6.0
	7M	13	28.7
May	13L	4	4.3
	7M	22	28.8
June	13L	5	4.4
	7M	13	32.5
2d quarter	13L	13	4.9
	7M	48	29.4

The average total beta activity added to the creek by ANL waste water was approximately 29 $\mu\mu c$ per liter. About 17 $\mu\mu c$ per liter (0.09 percent of the MPC) was due to thorium 234 and protoactinium 234, radioactive decay daughters of uranium. Other beta-emitting isotopes found in the creek as a result of their presence in ANL waste water were cobalt 58, strontium 90, and cesium 137. The concentrations of these isotopes are summarized in the following table.

---

[1] The values for MPC are one-tenth of the MPC allowed for continuous occupational exposure as given in "Handbook 69," National Bureau of Standards, issued June 5, 1959.

TABLE 10.—COBALT 58, STRONTIUM 90, AND CESIUM 137 IN SAWMILL CREEK WATER

Second Quarter 1960

[Average concentrations in μμc/liter]

Isotope	Location (see fig. 1)	Number samples	Activity
Cobalt 58	18L	4	[1] ND
	7M	8	5
Strontium 90	18L	6	1.1
	7M	17	1.6
Cesium 137	18L	6	.7
	7M	17	2.3

[1] Not detectable by methods used.

The absence of cobalt 58 in above-site water indicates that all the cobalt 58 below the outfall was added by ANL waste water. The strontium 90 and cesium 137 activities in the creek water above ANL resulted from fission product fallout. Since this water dilutes waste water by approximately one-half, the average concentrations of strontium 90 and cesium 137 added to the creek below the outfall were only about 1.0 and 2.0 μμc per liter, respectively. However, the total concentrations below the outfall were used to calculate the percentage of the MPC, since all manmade activity, regardless of source, must be used when evaluating the radiological hazard.

Analyses for other fission products were also made. These were either absent, or present so infrequently and in such small concentrations that they contributed negligible amounts of beta activity to the creek.

Since Sawmill Creek empties into the Des Plaines River, which in turn flows into the Illinois River, the radioactivity in the latter two streams is important. The Des Plaines River was sampled above and below the mouth of Sawmill Creek to determine if the radioactivity in Sawmill Creek had any effect on the activity in the river. The total activities and uranium concentrations found in the Des Plaines River are given in the following table.

TABLE 11.—TOTAL ALPHA, BETA, AND URANIUM ACTIVITIES IN DES PLAINES RIVER WATER

Second Quarter 1960

[Average concentrations in μμc/liter]

Month	Location (see fig. 8)	Number samples	Alpha	Beta	Uranium
April	A	2	1.5	8.1	0.9
	B	2	1.6	6.6	.9
May	A	3	2.4	7.7	1.5
	B	4	2.1	7.1	1.4
June	A	5	2.7	7.3	1.6
	B	5	2.6	7.8	1.6
2d quarter	A	10	2.4	7.6	1.4
	B	11	2.2	7.3	1.4

The sample collected on April 28 contained 1.4 μμc of uranium and less than 0.05 μμc of plutonium and thorium per liter. The sample collected at McKinley Woods State Park contained about 0.5 μμc of strontium 90 and less than 0.05 μμc of plutonium and thorium per liter. All of the results obtained for the Illinois River were in the range normally found for surface water in the area.

The alpha, beta, and uranium activities were uniformly low and in the range normally found in the Des Plaines River when fallout activity is low. There was no important or significant difference in activity between samples collected from the two locations. The activities were also similar to those found in other streams in the Chicago area during this period. The latter samples contained from 1 to 3 μμc of alpha activity per liter, 4 to 9 μμc of beta activity per liter and from 1 to to 2 μμc of uranium per liter. About one-third of the Des Plaines River samples were also analyzed for plutonium, thorium, cesium 137, and strontium 90. At both locations the strontium 90 and cesium 137 concentrations varied from 1 to less than 0.5 μμc per liter, and the plutonium and thorium concentrations were all less than 0.05 μμc per liter. Again, no difference was found between samples from the two locations. Apparently as a result of dilution of Sawmill Creek water by the much larger volume of water in the Des Plaines River, the radioactivity in Sawmill Creek had no detectable effect on the radioactivity in the Des Plaines River.

The Illinois River was sampled in April and May with the following results.

TABLE 12.—TOTAL ALPHA AND BETA ACTIVITY IN ILLINOIS RIVER

Second Quarter 1960

[Average concentrations in μμc/liter

Location	Date	Alpha	Beta
Morris	Apr. 28	1.8	4.9
Do.	May 26	1.4	4.7
McKinley Woods State Park	May 26	2.7	8.3
Starved Rock State Park	May 26	1.4	4.2

Radioactivity in Air

Air was sampled by drawing it through filter paper at a known rate and analyzed by measuring the radioactivity in the particles collected on the paper. Samples were collected continuously at five locations at the ANL site and at four locations near the site. The latter locations were near Aurora, Hinsdale, Joliet, and Tinley Park. The filter papers were changed at weekly intervals. Monthly averages of the results are tabulated below.

TABLE 13.—RADIOACTIVITY IN AIR FILTER SAMPLES

Second Quarter 1960

[Average concentrations in μμc/m³]

Month	Location	Number samples	Alpha	Beta
April	On site	14	0.006	0.15
	Off site	8	.004	.14
May	On site	22	[illegible]	.12
	Off site	12	[illegible]	.12
June	On site	17	[illegible]	.13
	Off site	16	[illegible]	.14
2d quarter	On site	54	[illegible]	.13
	Off site	36	[illegible]	.13

These results were obtained by measuring the samples 3 days after they were collected in order to avoid counting the natural radioactivity due to radon and thoron decay products. This activity, normally present in the air and in considerably larger amounts than the activities expected from fallout or from ANL, disappears within 3 days by radioactive decay.

The alpha and beta activities given in table 11 are due to a number of radioactive isotopes present in the air samples. The application of MPC's to such mixtures is somewhat different than in the case of a single isotope. Handbook 69 (p. 94) recommends a series of MPC's which become progressively larger as some of the more hazardous isotopes are eliminated from the mixture. For the samples collected near ANL, the applicable MPC is 100 μμc per cubic meter. The total average air activity during the quarter, 0.135 μμc per cubic meter, is then about 0.14 percent of the MPC. Within the sample collection and analytical error of 10 to 20 percent, the average alpha and beta activities were essentially the same on and off the ANL site. Individual samples collected at the same time from different locations may show differences somewhat greater than this error due to a variety of factors, including the amount of dust in the air at each location. Such differences become unimportant when comparisons are made between the averages of a large number of samples. If activity used at ANL were discharged to the atmosphere, higher activities would be expected on the site. Since this was not the case, ANL did not add significantly to the airborne radioactivity of the environment. Additional evidence to support this conclusion is given in the table below.

TABLE 14.—RELATIVE CONCENTRATIONS OF CERIUM 144, RUTHENIUM 106, AND CESIUM 137 IN AIR FILTER SAMPLES

Second Quarter 1960

[Average concentrations in cpm/1000 m³]

Month	Cerium 144		Ruthenium 106		Cesium 137	
	At ANL	Near ANL	At ANL	Near ANL	At ANL	Near ANL
April	2.67	2.29	3.42	4.05	3.28	3.94
May	2.20	2.42	2.66	2.98	2.82	2.81
June	2.59	2.63	3.66	4.08	3.04	3.34

This table gives the relative concentrations of the principal gamma-ray emitting fission products present in all the air samples collected during the quarter. The results parallel the total beta activity (all three isotopes emit beta particles as well as gamma rays) in that they show a decrease in May relative to April and June. The concentrations of these fission products are in all cases 10 to 15 percent higher off the ANL site than on the site. This is within the sampling and analytical errors, but if the differences were due only to these errors, it would be unlikely for the results to be consistently higher off the site. The exact reasons for this discrepancy are not known at present, but the results are in agreement with the interpretation that these fission products did not originate at ANL, but came from outside and widespread sources, such as fallout from nuclear test detonations.

The total alpha activities were similar to those found earlier; the beta activities were about 20 times lower than those found from 1957 to 1959 and 35 percent higher than observed during the first quarter of 1960. The variations in beta activity were due to variations in the amount of fission product fallout. Except for two relatively small nuclear detonations in February 1960 (French), fission products from nuclear testing have not been added to the atmoshere since the end of 1958. Consequently, a sharp drop in airborne beta activity in 1960 relative to 1959 was expected. The small increase during the spring and early summer of 1960 over the winter months probably was due to meteorological conditions resulting in increased fallout of fission products stored in the stratosphere from earlier testing. Since short-lived fission products were not present in the air samples collected during the second quarter of 1960, the increase was not due to the February detonations. Additional information on the air-sampling program and on the interpretation of results, together with the air activities since 1953, are given in the first report in this series.

Feed Materials Production Center

National Lead Co. of Ohio, Fernald, Ohio, Issued January 13, 1961

Environmental levels of radioactivity at the Feed Material Production Center (FMPC) are reported for the first time in this issue. The following report summarizes the data for 1959 and the first and second quarters of 1960.

The FMPC is operated by the National Lead Co. of Ohio (NLO) for the Atomic Energy Commission (AEC). Feed material operations deal with the processing of high-grade uranium ores and ore concentrates to produce metallic uranium. The final product is used in the United States as a fuel for reactors.

During the many involved reactions and processes that lead to the reactor fuels, various liquid and airborne wastes are generated. Various in-plant methods are used to curtail their release into the environment surrounding the plant. Almost complete removal of the materials is accomplished by using dust collectors and waste treatment processes. Since it is impossible to obtain 100 percent removal, some of the material does reach the environs outside the plant. An environmental survey program consisting of water and air sampling of the the environs has been established. The results from the second-quarter sampling revealed that the control of material released to the environs at this site is well within the maximum permissible concentrations (MPC) as recommended by the National Committee on Radiation Protection and Measurements and as adopted by the State of Ohio.

Water Sampling

Water samples are taken to determine the effect of the site's liquid wastes upon the Great Miami River, into which all of the plant's liquid effluents pass. The results of the monitoring of liquid effluents have been reported to the Ohio Department of Health on a monthly basis since 1954, and duplicate samples are often taken by a State engineer and an NLO industrial hygienist. In some cases, samples are exchanged in order that each group may evaluate the other's sampling procedure and analytical results.

The locations of all of the water sampling points are shown in figure 9. A continuous-type water sampler collects the plant effluent at the outfall (point B). Since it is difficult to have this type of sampler in an upstream (point A) and downstream location (point C), spot samples are taken at these points. The collected samples are analyzed for uranium, total radioactivity, chlorides, fluorides, and nitrates.

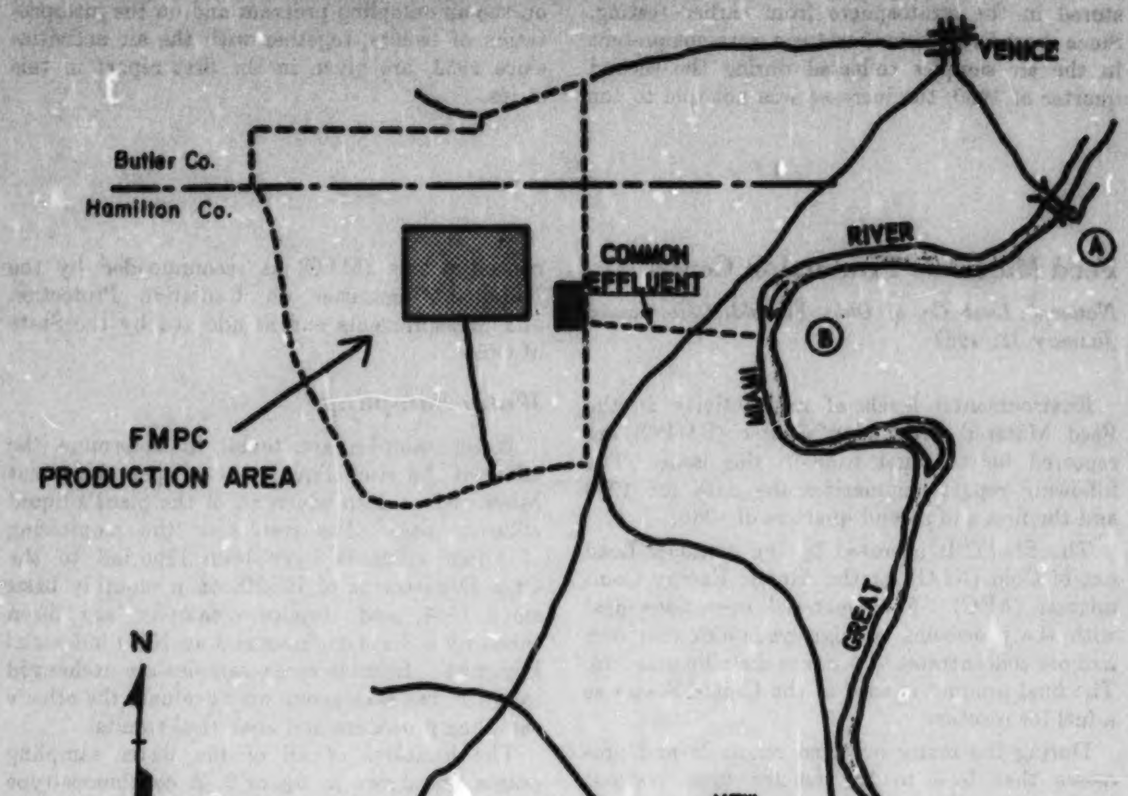
The results in table 15 indicate that the liquid wastes discharged by this plant during the second quarter were small in relation to the MPC's. Results C minus A (the difference in upstream and downstream concentrations) indicate that the FMPC effluent produced little or no change in the river's quality.

TABLE 15.—RADIOACTIVITY IN GREAT MIAMI RIVER WATER

[Average concentrations in $\mu\mu c$/liter]

Location	Calendar year 1959			1st quarter 1960			2d quarter 1960		
	Number of samples	Uranium	Total activity	Number of samples	Uranium	Total activity	Number of samples	Uranium	Total activity
Upstream (A)	22	4.0	60	12	6.7	31	15	12	70
Outfall (B)	365	1.0	5	91	.4	2	91	6	9
Downstream (C)	23	4.7	60	12	9.0	38	15	20	90
C−A	....	.7	0	....	2.3	7	....	8	20

FIGURE 9.—WATER SAMPLING LOCATIONS, FERNALD FMPC AND SURROUNDINGS



Air Sampling

Air samples and gumpapers from fallout stations are collected around the 1,000-acre plant site and at points as far away as 15 miles. The sampling of airborne particulate matter provides a good indication of the amount of material released into the atmosphere by the plant. The amount of particulates in the air is calculated by drawing a known quantity of air through a filter paper analyzing the paper for uranium and total activity. The air-sampling locations in the production area are shown in figure 10.

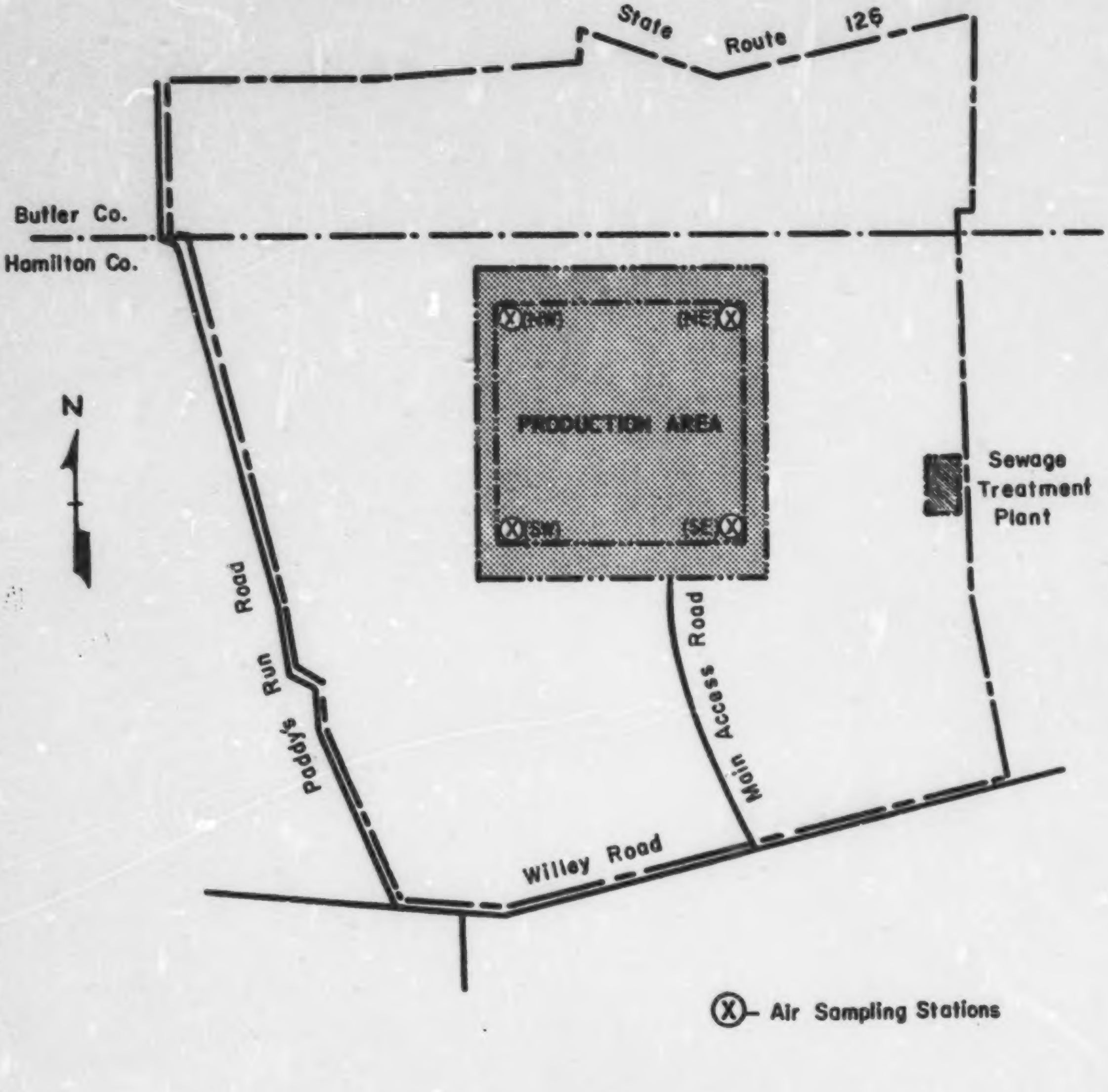
Due to construction work being carried out at the FMPC, it was not possible to conduct the routine air-sampling program during the first quarter. Only two stations were in operation during the second quarter. It should be pointed out that the two stations that were in operation were predominantly downwind, since the wind is usually from a southwesterly direction. The results of the sampling indicate that even within the project area owned and controlled by the AEC, the concentrations were always well within the maximum permissible concentrations.

TABLE 16.—RADIOACTIVITY IN AIR FILTER SAMPLES

[Average concentrations in $\mu\mu c/m^3$]

Location	Calendar year 1959			1st quarter 1960	2d quarter 1960		
	Number samples	Uranium	Total activity		Number samples	Uranium	Total activity
Southwest	13	0.131	0.87	No samples taken	No samples taken		
Northwest	8	.108	.84		10	0.20	0.43
Northeast	19	.115	.78		10	.15	.37
Southeast	18	.060	.60		No samples taken		
Plant average	----------	.104	.77		----------	.175	.40

FIGURE 10.—AIR SAMPLING LOCATIONS, FERNALD FMPC AND SURROUNDINGS


State Route 126
Butler Co.
Hamilton Co.
N
(X) (NW)
(NE) (X)
PRODUCTION AREA
(X) (SW)
(SE) (X)
Sewage Treatment Plant
Paddy's Run Road
Main Access Road
Willey Road
(X)– Air Sampling Stations

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RADIOLOGICAL HEALTH DATA

MONTHLY REPORT MAY 1961

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service • Division of Radiological Health

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SECTION I.—AIR

Radiation Surveillance Network

Division of Radiological Health, Public Health Service

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in levels of environmental radioactivity due to fallout from nuclear weapons tests. Although no nuclear tests have been conducted by the United States since 1958, the program has proved sufficiently valuable that it has been extended to a year-round basis. Currently, it consists of 45 stations at urban locations (see fig. 1) operated by State and local health department personnel with 2 of the stations operated by Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. Field measurements enable the operator to estimate the amount of beta activity of particulates in air at the station 5 hours after collection by comparison with a known source using a portable survey meter. The filters are then forwarded to the central laboratory of the Radiation Surveillance Network in Washington, D.C., for a more refined measurement using a thin window proportional counter. The stations located at Atlanta, Ga., and Cincinnati, Ohio, conduct their own laboratory analyses.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a carbon-loaded cellulose dust filter using a high volume air sampler. The radioactive material in fallout adhering to small particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples. About 85 percent of the stations collected samples of precipitation which are sent to Washington, D.C., for analysis. Values are now below limits of detection by present instrumentation.

Tables 1 and 2 summarize the data for December 1960.

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS.

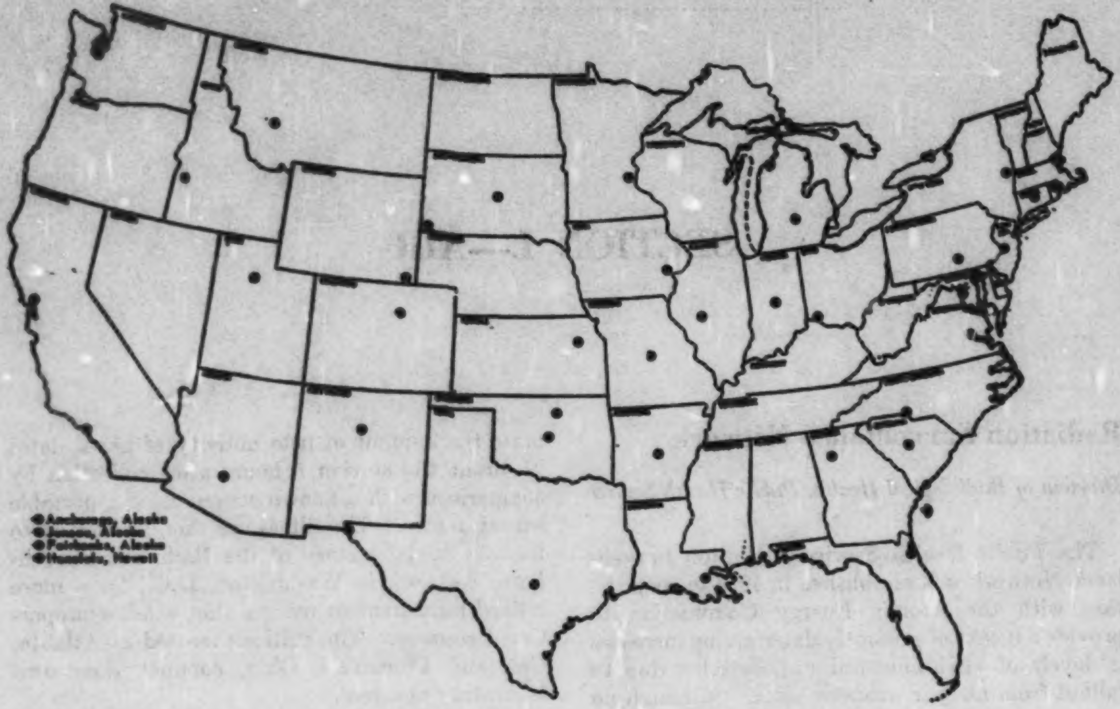

TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR—GROSS BETA DETERMINATIONS

Radiation Surveillance Network, Public Health Service, December 1960

Station location	Number of samples	Maximum (μμc/m³)	Minimum (μμc/m³)	Weighted average (μμc/m³)	Station location	Number of samples	Maximum (μμc/m³)	Minimum (μμc/m³)	Weighted average (μμc/m³)
Anchorage, Alaska	21	<0.10	<0.10	<0.10	Pascagoula, Miss	19	0.18	<0.10	<0.11
Fairbanks, Alaska	21	<.10	<.10	<.10	Jefferson City, Mo	21	<.10	<.10	<.10
Juneau, Alaska	16	<.10	<.10	<.10	Helena, Mont	20	<.10	<.10	<.10
Phoenix, Ariz	2	<.10	<.10	<.10	Trenton, N.J	1	<.10	<.10	<.10
Little Rock, Ark	20	<.10	<.10	<.10	Santa Fe, N. Mex	15	.13	<.10	<.10
Berkeley, Calif	21	.13	<.10	<.10	Albany, N.Y	26	.16	<.10	<.10
Los Angeles, Calif	21	.16	<.10	<.11	Gastonia, N.C	16	.20	<.10	<.11
Denver, Colo	24	.15	<.10	<.10	Cincinnati, Ohio	21	.10	.02	.06
Hartford, Conn	31	.11	<.10	<.10	Oklahoma City, Okla	15	.10	<.10	<.10
District of Columbia	25	.14	<.10	<.10	Ponca City, Okla	30	<.10	<.10	<.10
Jacksonville, Fla	20	<.10	<.10	<.10	Portland, Oreg	20	.17	<.10	<.11
Atlanta, Ga	14	.12	.08	.07	Harrisburg, Pa	13	.11	<.10	<.10
Honolulu, Hawaii	21	<.10	<.10	<.10	Providence, R.I	21	.17	<.10	<.10
Boise, Idaho	3	<.10	<.10	<.10	Columbia, S.C	7	<.10	<.10	<.10
Springfield, Ill	15	<.10	<.10	<.10	Pierre, S. Dak	5	.10	<.10	<.10
Indianapolis, Ind	20	<.10	<.10	<.10	Austin Tex	19	<.10	<.10	<.10
Iowa City, Iowa	19	<.10	<.10	<.10	El Paso, Tex	20	.24	<.10	<.13
Topeka, Kans	20	<.10	<.10	<.10	Salt Lake City, Utah	31	.12	<.10	<.10
New Orleans, La	4	<.10	<.10	<.10	Richmond, Va	21	.12	<.10	<.10
Baltimore, Md	20	.11	<.10	<.10	Seattle, Wash	21	.10	<.10	<.10
Lawrence, Mass	20	<.10	<.10	<.10	Cheyenne, Wyo	9	<.10	<.10	<.10
Lansing, Mich	20	<.10	<.10	<.10	Madison, Wis	17	<.10	<.10	<.10
Minneapolis, Minn	9	<.10	<.10	<.10					

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Table 2.—RADON AND THORON MEASUREMENTS

Public Health Service Radiation Surveillance Network, Station at Cincinnati, Ohio, December 1960

Day	Continuous sample collection			Radon [a] a.m. ($\mu\mu c/m^3$)	Radon-thoron [b] p.m. ($\mu\mu c/m^3$)	Thoron [c] ($\mu\mu c/m^3$)	Beta [d] activity ($\mu\mu c/m^3$)
	Sample change time	Sample period (hours)	Volume (m^3)				
1	0815	23.90	28.29	100	100	2.2	0.12
2	0822	24.00	27.40	250	90	4.2	.08
5	0820	71.98	83.90	250	90	5.9	.07
6	0815	23.67	28.00	250	120	4.4	.19
7	0835	24.30	28.80	230	160	3.0	.14
8	0827	23.73	27.28	300	160	3.8	.14
9	0814	23.95	28.15	300	100	2.6	.07
12	0842	72.45	85.82	160	90	2.7	.05
13	0835	23.88	29.19	110	50	1.1	.08
14	0825	23.76	28.81	190	60	1.4	.06
15	0827	24.05	29.17	180	140	1.6	.05
16	0830	23.85	29.14	110	150	1.7	.07
19	0828	72.10	84.93	210	180	2.4	0.05
20	0822	23.88	28.89	340	150	.8	.02
21	0825	24.00	28.54	120	300	1.2	.02
22	0828	23.95	28.87	240	150	1.1	.13
23	0838	24.28	30.07	280	130	1.2	.00
27	0806	95.46	112.81	40	170	1.0	.03
28	0807	22.95	28.27	220	80	.07	.03
29	0812	24.07	28.91	430	190	1.1	.04
30	0813	23.97	28.99	170	210	1.4	.12
Jan. 3, 1961	0810	95.95	113.90	190	160	.8	.04
Average				210	180	2.4	.06

[a] Radon concentrations are derived from alpha measurements determined immediately after the sampling period (24 to 96 hours) has ceased. Reported radon concentrations have been corrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±10 and ±40 $\mu\mu c/m^3$.

[b] Radon concentrations are derived from alpha measurements made in the afternoon (3 p.m.) approximately 7 hours after the new sampling period has begun. Therefore, the reported values were actually determined one day prior to the date reported here. Reported radon concentrations are uncorrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±10 and ±30 $\mu\mu c/m^3$.

[c] Thoron concentrations are derived from alpha measurements referred to in footnote (a) but are counted 7 hours after the sampling period (24 to 96 hours) has ceased. The values reported here have been corrected to the time of removal from the filter holder. Twice the standard deviation (2σ) falls between ±0.1 and ±0.5 $\mu\mu c/m^3$.

[d] Gross beta concentrations are based on measurements made at least 4 days after each sampling period (24 to 96 hours) has ceased. Twice the standard deviation (2σ) falls between ±0.07 and ±0.08 $\mu\mu c/m^3$.

Radioactivity Measurements in Air

U.S. Naval Research Laboratory

Radioactivity measurements of air-filter samples collected at various sites near the 80th Meridian (West) are made by the U.S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during December 1960 is presented in table 1, and the radioactivity profile for the same month is shown in figure 1. This figure now illustrates the data plotted in semilogarithmic coordinates. Previously the data were presented in rectangular coordinates with the abscissa expressed in disintegrations per minute per cubic meter. The concentrations in table 1 are expressed in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

Table 1.—DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION

U.S. Naval Research Laboratory, December 1960

[Disintegrations/minute per cubic meter]

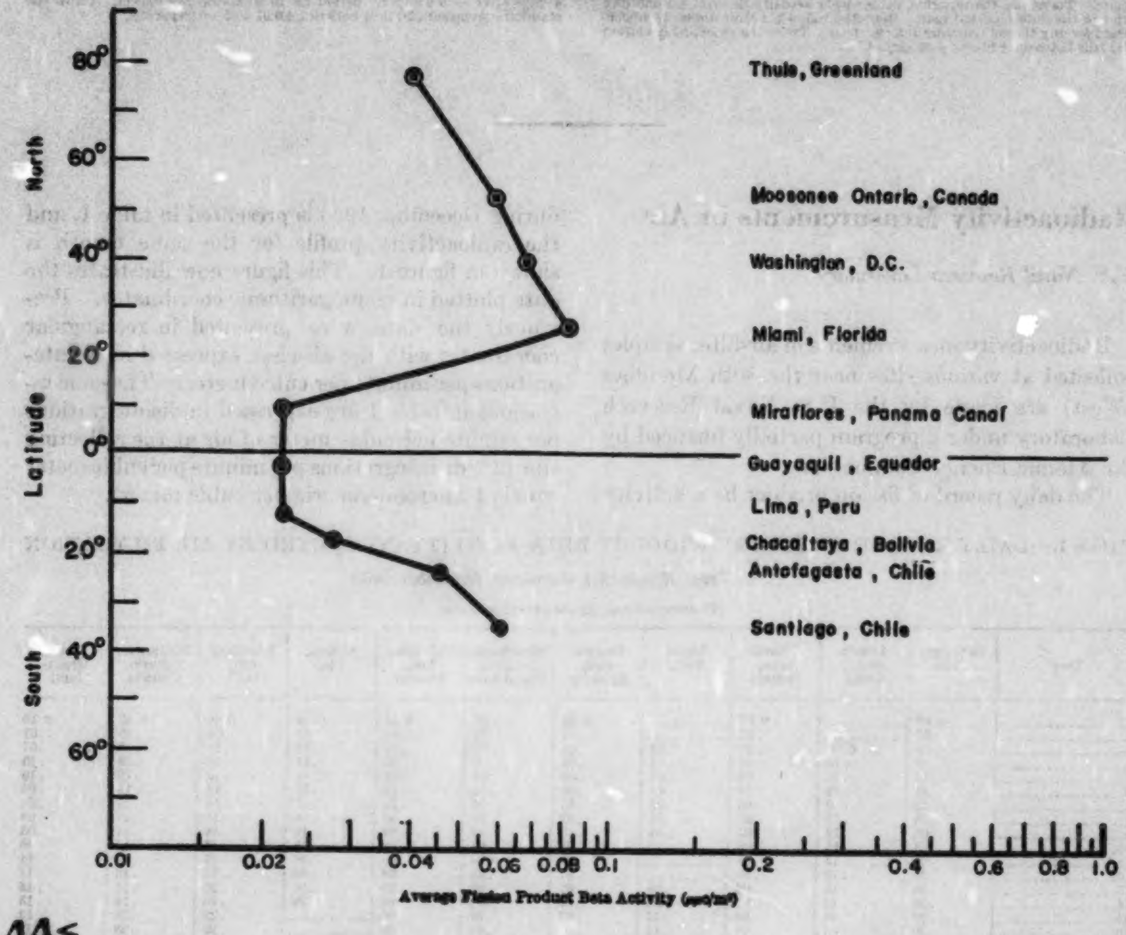
Day	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal Zone	Mauna Loa, Hawaii	Miami, Fla.	Washington, D.C.	Moosonee, Ontario, Canada	Thule, Greenland
1	0.07	----------	0.07	----------	0.04	0.01	0.04	0.19	0.06	0.10	0.10
2	.07	----------	.07	----------	.04	.01	.04	.19	.06	.10	.07
3	.13	0.16	.06	0.08	.05	.01	.03	.11	.10	.18	.07
4	.13	.16	.06	.08	.05	.01	.03	.11	.10	.18	.10
5	.13	.16	.06	.03	.06	.01	.03	.11	.10	.18	.10
6	.22	.10	.04	.05	.06	.03	.11	.17	.14	.15	.04
7	.22	.10	.05	.05	.03	.03	.11	.17	.14	.15	.04
8	.06	.12	.07	.04	.03	.03	.09	.14	.14	.13	.04
9	.06	.12	.04	.04	.03	.03	.09	.14	.14	.13	.08
10	.08	.13	.03	----------	.03	.04	.08	.10	.13	.12	.08
11	.08	.13	.04	----------	.03	.04	.08	.10	.13	.12	.14
12	.08	.13	.06	----------	.07	.04	.08	.10	.13	.12	.14
13	.20	.13	.08	.08	.07	.02	.05	.20	.26	.14	.15
14	.20	.13	.07	.08	.07	.02	.05	.20	.26	.14	.13
15	.10	.06	.06	.13	.07	.02	.06	----------	.23	.28	.13
16	.10	.06	.04	.13	.07	.02	.06	----------	.23	.28	.12
17	.06	.06	.05	.03	----------	.04	.04	.33	.17	.13	.13

TABLE 1. DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION—Continued

Day	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal Zone	Mauna Loa, Hawaii	Miami, Fla.	Washington, D.C.	Moosonee, Ontario, Canada	Thule, Greenland
[illegible]	0.08	0.08	0.08	0.08	- - -	0.04	0.04	0.22	0.17	0.12	0.11
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	- - -	[illegible]	[illegible]	.22	.17	.13	.11
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	- - -	[illegible]	[illegible]	[illegible]	.13	[illegible]	.11
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	- - -	[illegible]	[illegible]	[illegible]	.13	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	- - -	[illegible]	[illegible]	- - -	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	- - -	[illegible]	[illegible]	- - -	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	- - -	[illegible]	[illegible]	.27	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.11	[illegible]	- - -	[illegible]	[illegible]	.27	[illegible]	.11	[illegible]
[illegible]	[illegible]	[illegible]	.07	[illegible]	[illegible]	[illegible]	[illegible]	.27	[illegible]	.11	[illegible]
[illegible]	.17	[illegible]	.07	[illegible]	[illegible]	[illegible]	[illegible]	.19	[illegible]	- - -	[illegible]
[illegible]	.17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.19	.15	- - -	[illegible]
[illegible]	- - -	[illegible]	[illegible]	- - -	[illegible]	.14	[illegible]	[illegible]	.15	[illegible]	[illegible]
[illegible]	- - -	[illegible]	[illegible]	[illegible]	.07	.14	[illegible]	[illegible]	.13	[illegible]	.11
[illegible]	- - -	[illegible]	[illegible]	[illegible]	.07	.14	[illegible]	[illegible]	.11	.07	.11
Mean value.	.13	.10	.06	.05	.05	.06	.05	.19	.15	.10	.09

FIGURE 1.—PROFILE OF BETA ACTIVITY

Average Measurements of Surface Air at Stations Near the 80th Meridian (West), U.S. Naval Research Laboratory
December 1960



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SECTION II.—MILK

Milk Monitoring Program

Division of Radiological Health, Public Health Service

The original Public Health Service Milk Monitoring Program consisted of 12 sampling stations, of which 9 are still active. Raw milk is spot sampled at these stations. During 1960 a new sampling program of 60 stations was established. Processed milk is sampled at these stations. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Ala., and the Southwestern Radiological Health Laboratory at Las Vegas, Nev., provide analytical services for the new program.

The purposes of the two sampling programs are not the same. The original network was established to develop sampling and radiochemical analytical proficiencies under conditions which would remain similar over a period of time in regard to the source of milk. During the operation of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary. The Public Health Service and the Department of Health, Education, and Welfare acted to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances, the newly designated stations are the same as those which were reported originally. The establishment of the new processed milk area sampling stations does not preclude the need for further raw milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the method of collecting samples, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers many factors, including laboratory methodology and collection methods. Until this study has been completed and additional experience has been gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data will normally follow about 4 months after collection of samples because of the time required for shipment, processing, decay product buildup, compilation of the data, and clearance and publication procedures.

Raw Milk Sampling Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment with respect to measuring the amounts of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures which would make them more suitable for larger scale programs.

The criteria on which the selection of the original sampling stations was based appeared in the discussion sections of all Volume I issues of *Radiological Health Data.*

One-gallon raw milk samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analyses. It is estimated that these samples represent 2,000-gallon lots. The concentrations of iodine-131, barium-140, cesium-137, and naturally occurring potassium-40 are all currently being measured by gamma scintillation spectroscopy. Total radiostrontium and strontium-90 are determined following radiochemical separations. The amount of strontium-90 is calculated by measuring the buildup of the strontium-90 daughter decay product, yttrium-90, over a 2-week period. Measurements are made with a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-89 calculated as the difference between this value and strontium-90. Stable calcium is also determined.

April through September 1960 issues of *Radiological Health Data* list references for technical descriptions of the methodology of analyses used.

December data for the raw milk sampling stations are presented in table 1.

Processed Milk Area Sampling Stations

The monitoring of milk has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. Each city has been selected to provide adequate coverage with respect to production areas and the consuming population. The emphases on this expanded sampling and radioassay program are—

1. Measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant, and
2. Providing one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving milk production and milkshed area characteristics.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from 1 day's sales per month in a community which would be as representative of the total supply as can be achieved under practical conditions. Each sample is a composite of those plants supplying not less than 90 percent of a city's milk supply. The contribution from each plant to the total sample is approximately proportional to volume of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analyses to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 States generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the Western States. Figure 1 shows the locations of these stations.

At the present time radioassays for Sr^{89}, Sr^{90}, Cs^{137}, Ba^{140}, and I^{131} are being performed. To date, the latter two isotopes have been below present limits of detection. Other radionuclides of concern to public health agencies will be included for assay as necessary for more complete monitoring of the milk supply.

December data from the two laboratories are presented in table 2.

TABLE 1.—RADIOACTIVITY IN MILK—RAW MILK SAMPLING STATIONS, DECEMBER 1960

Milk Monitoring Program, Public Health Service, Robert A. Taft Sanitary Engineering Center

[Radioactivity concentrations in μμc/liter]

Area	Calcium (grams/liter)		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	December	Yearly average	December	Yearly average	December	Yearly average	December	Yearly average	December	Yearly average	December	Yearly average
Atlanta, Ga.	1.25	1.13	ND[1]	<10	ND	<5	11	15	ND	<10	20	25
Austin, Tex.	1.15	1.11	ND	<10	ND	<5	4	4	ND	<10	10	15
Chicago, Ill.	1.10	1.10	ND	<10	ND	<5	8	9	ND	<10	15	20
Cincinnati, Ohio	1.18	1.13	ND	<10	ND	<5	7	10	ND	<10	20	25
New York, N.Y.	1.11	1.10	ND	<10	ND	<5	8	9	ND	<10	15	25
Sacramento, Calif.	1.21	1.12	ND	<10	ND	<5	2	8	ND	<10	5	10
Salt Lake City, Utah	1.17	1.11	ND	<10	ND	<5	[illegible]	8	ND	<10	5	20
Spokane, Wash.	1.24	1.13	ND	<10	ND	<5	6	11	ND	<10	20	25
St. Louis, Mo.	1.30	1.23	ND	<10	ND	<5	[illegible]	16	ND	<10	15	20

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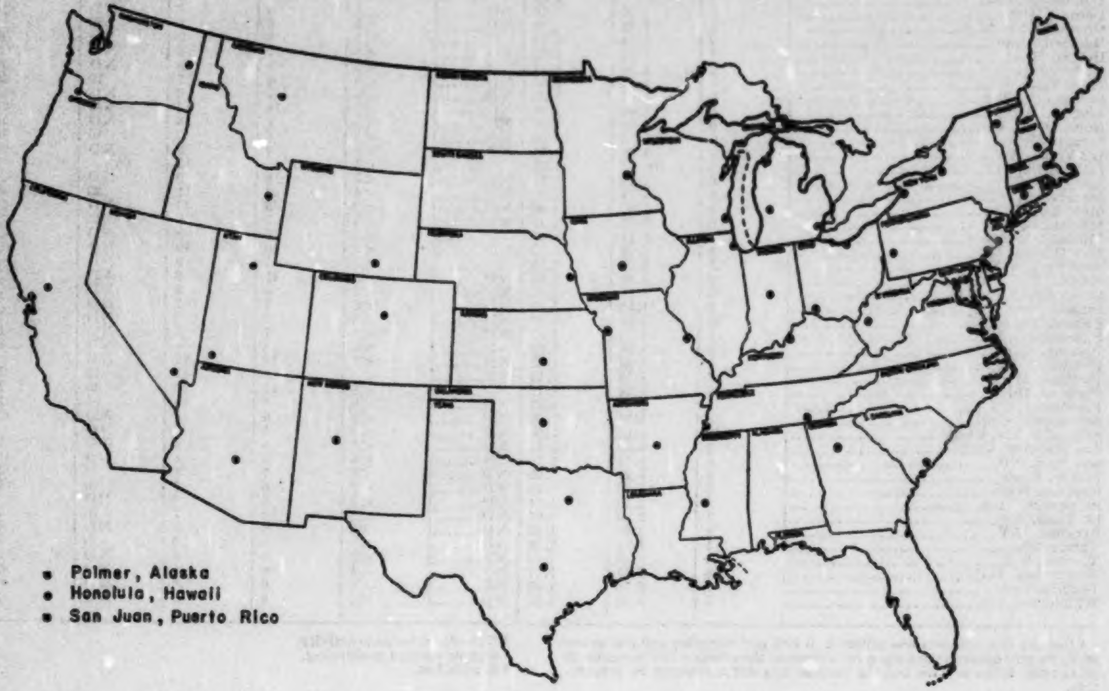
[1] ND—No detectable activity.

FIGURE 1.—PROCESSED MILK AREA SAMPLING STATIONS



- Palmer, Alaska
- Honolulu, Hawaii
- San Juan, Puerto Rico

TABLE 2.—RADIOACTIVITY IN MILK—PROCESSED MILK AREA SAMPLING STATIONS, DECEMBER 1960

Milk Monitoring Program, Public Health Service

[Radioactivity concentrations in μμc/liter]

Area	Number[1] of months reported	Calcium (grams/liter)		Strontium-89		Strontium-90		Cesium-137	
		December	Average to date	December	Average to date	December	Average to date	December	Average to date
Albuquerque, N. Mex.	10	1.14	1.10	ND[2]	<5	6	4	ND	5
Atlanta, Ga.	5	1.24	1.24	ND	<5	8	10	ND	<5
Austin, Tex.	7	1.29	1.18	ND	<5	2	2	ND	5
Baltimore, Md.	8	1.21	1.18	ND	<5	10	8	ND	<5
Boston, Mass.	7	1.25	1.19	ND	<5	10	12	ND	15
Buffalo, N.Y.	7	1.21	1.16	ND	<5	8	7	ND	<5
Burlington, Vt.	9	1.23	1.20	ND	<5	8	9	ND	10
Charleston, S.C.	5	1.40	1.27	ND	<5	13	10	ND	5
Charleston, W. Va.	9	1.29	1.18	ND	<5	9	9	ND	<5
Charlotte, N.C.	7	1.29	1.20	ND	<5	12	12	ND	5
Chattanooga, Tenn.	4	1.34	1.21	ND	<5	10	10	ND	<5
Chicago, Ill.	6	1.20	1.15	ND	<5	6	6	ND	<5
Cincinnati, Ohio	8	1.27	1.16	ND	<5	9	8	ND	<5
Cleveland, Ohio	6	1.23	1.16	ND	<5	7	8	ND	<5
Dallas, Tex.	7	1.30	1.22	ND	<5	6	6	ND	<5
Denver, Colo.	10	1.14	1.10	ND	<5	10	7	10	10
Des Moines, Iowa	7	(3)	1.04	(3)	<5	(3)	8	(3)	15
Detroit, Mich.	8	1.20	1.16	ND	<5	8	7	ND	<5
Grand Rapids, Mich.	6	1.22	1.26	ND	<5	6	7	20	5
Hartford, Conn.	9	1.24	1.19	ND	<5	8	9	ND	10
Helena, Mont.	7	1.20	1.08	ND	<5	5	6	ND	10
Honolulu, Hawaii	9	1.16	1.07	ND	<5	4	5	ND	20
Idaho Falls, Idaho	10	1.13	1.07	ND	<5	4	5	10	20
Indianapolis, Ind.	6	1.24	1.20	ND	<5	7	6	ND	<5
Jackson, Miss.	5	1.30	1.21	ND	<5	14	12	ND	<5
Kansas City, Mo.	6	1.08	1.08	ND	<5	7	5	ND	10
Laramie, Wyo.	9	1.14	1.08	ND	<5	6	5	10	10
Las Vegas, Nev.	8	1.01	1.05	ND	<5	4	3	ND	5
Little Rock, Ark.	5	(4)	1.21	(4)	<5	(4)	13	(4)	<5
Louisville, Ky.	9	1.24	1.10	ND	<5	8	9	ND	<5
Manchester, N.H.	9	1.24	1.20	ND	<5	8	11	20	25
Memphis, Tenn.	4	1.27	1.28	ND	<5	9	10	ND	<5
Milwaukee, Wis.	6	1.25	1.17	ND	<5	5	6	ND	<5
Minneapolis, Minn.	5	1.11	1.06	ND	<5	5	8	ND	<5
New Orleans, La.	6	1.24	1.26	ND	<5	10	13	ND	<5
New York, N.Y.	7	1.24	1.14	ND	<5	7	9	ND	5
Norfolk, Va.	6	1.28	1.20	ND	<5	11	9	ND	<5
Oklahoma City, Okla.	6	1.16	1.16	ND	<5	6	8	ND	<5
Omaha, Nebr.	5	1.05	1.04	ND	<5	7	7	ND	5
Palmer, Alaska	10	1.08	1.07	ND	<5	6	7	ND	10
Philadelphia, Pa.	7	1.26	1.17	ND	<5	7	8	ND	10
Phoenix, Ariz.	6	1.15	1.02	ND	<5	5	4	ND	15
Pittsburgh, Pa.	9	1.26	1.22	ND	<5	12	12	ND	5
Portland, Maine	7	1.18	1.14	ND	<5	8	11	10	15
Portland, Oreg.	9	1.20	1.12	ND	<5	11	10	10	20
Providence, R.I.	7	1.40	1.21	ND	<5	8	11	5	10
Sacramento, Calif.	8	1.14	1.08	ND	<5	6	5	ND	<5
Salt Lake City, Utah	10	1.14	1.09	ND	<5	5	6	ND	5
San Francisco, Calif.	7	1.22	1.11	ND	<5	6	4	ND	10
San Juan, P.R.	6	1.18	1.16	ND	<5	4	4	ND	<5
Seattle, Wash.	9	1.21	1.09	ND	<5	7	8	10	20
Spokane, Wash.	8	1.23	1.09	ND	<5	6	7	10	20
St. George, Utah	5	1.10	1.04	ND	<5	5	5	ND	5
St. Louis, Mo.	5	1.10	1.05	ND	<5	10	7	20	25
Syracuse, N.Y.	9	1.26	1.28	ND	<5	6	7	ND	10
Tampa, Fla.	5	1.28	1.26	ND	<5	6	5	20	75
Trenton, N.J.	7	1.47	1.23	ND	<5	6	8	ND	5
Washington, D.C.	6	1.21	1.17	ND	<5	6	8	ND	<5
Wichita, Kans.	9	1.16	1.08	ND	<5	6	6	ND	<5
Wilmington, Del.	7	1.24	1.21	ND	<5	8	8	ND	10

[1] Because this program was initiated in 1960 and sampling stations necessarily became operative in a staggered sequence, the averages shown represent all samples taken to date, but the months may not necessarily be consecutive.

[2] ND—No detectable activity.

[3] Sample curdled in shipping.

[4] Sample lost.

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SECTION III.—WATER

National Water Quality Network

Division of Water Supply and Pollution Control Public Health Service

The National Water Quality Network was established under the provision of section 4(c) of Public Law 660, which states "* * * The Surgeon General shall * * * collect and disseminate basic data * * * [relating] to water pollution and the prevention and control thereof."

This network, operated in cooperation with State and local health agencies, was started in October 1957. At present, there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses. Some of these stations are on interstate, coastal, and international boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately, a total of 250 to 300 stations will be in operation. A few of the more recently established stations have not begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The levels of radioactivity associated with dissolved solids provide a rough measure of levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from manmade sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River.

While beta determinations for the first 2 years of the network operation have been conducted on each sample weekly, the alpha determinations are reported generally on a composite sample of more than 1 week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on 3-month composite samples, with one-third of the stations being covered each month. All the data reported in table 1 represent the average of all information available for the month indicated.

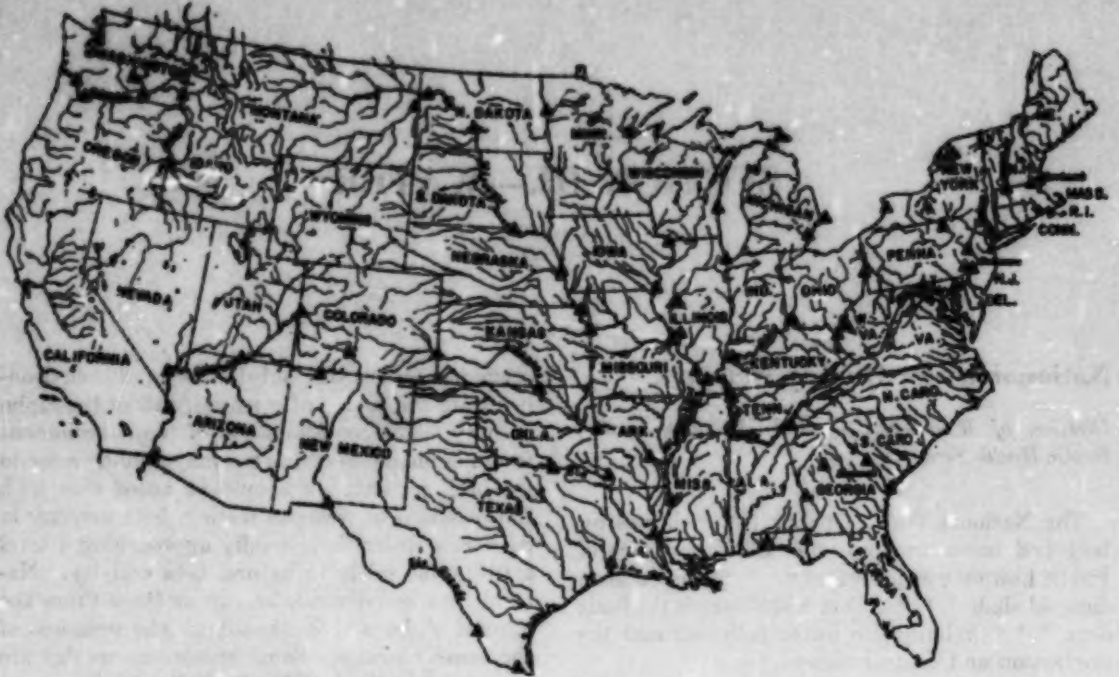
Strontium-90 data reported are the results of determinations on composite samples for a 3-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

National Water Quality Network Annual Compilation of Data, PHS Publication. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $1.50.

Report on National Water Quality Control Network, submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy Hearings on Fallout From Nuclear Weapons Tests, Volume 1, May 1959, pages 167–169.

FIGURE 1.—PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS


WASHINGTON
OREGON
IDAHO
MONTANA
N. DAKOTA
MINN.
WISCONSIN
S. DAKOTA
WYOMING
NEBRASKA
IOWA
MICHIGAN
NEW YORK
MASS.
R.I.
CONN.
PENNA.
N.J.
DEL.
OHIO
IND.
ILLINOIS
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
W. VA.
VA.
KENTUCKY
CALIFORNIA
ARIZONA
NEW MEXICO
OKLA.
ARK.
TENN.
N. CARO.
S. CARO.
MISS.
ALA.
GEORGIA
TEXAS
FLORIDA

As of June 30, 1960

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Concentrations in μμc/liter]

Station	Quarter ending Sept. 30, 1960	November 1960					
	Strontium-90	Beta activity			Alpha activity		
		Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River: Cedar Hill, N. Mex.	0.4	4	17	21	7	22	29
Apalachicola River: Chattahoochie, Fla.	.5	0	0	0	—	—	—
Arkansas River:							
Coolidge, Kans.	.8	0	0	0	3	60	63
Ponca City, Okla.	(1)	0	0	0	1	5	6
Pendleton Ferry, Ark.		100	0	100	20	4	24
Chattahoochie River:							
Atlanta, Ga.		0	1	1	—	—	—
Columbus, Ga.		0	1	1	—	—	—
Colorado River:							
Loma, Colo.		0	0	0	1	13	14
Page, Ariz.		39	32	71	13	20	33
Hoover Dam, Ariz.-Nev.	1.0	0	11	11	0	11	11
Parker Dam, Airz.-Calif.		0	6	6	0	10	10
Yuma, Ariz.		0	0	0	2	6	8
Columbia River:							
Wenatchee, Wash.		0	0	0	0	1	1
Bonneville Dam, Oreg.		9	197	206	—	—	—
Clatskanie, Oreg.	.3	4	94	98	0	1	1
Connecticut River: Northfield, Mass.		0	1	1	0	0	0
Delaware River:							
Martin's Creek, Pa.		0	0	0	0	1	1
Philadelphia, Pa.		0	0	0	2	0	2
Escambia River: Century, Fla.		0	0	0	1	1	2
Great Lakes:							
Gary, Ind.	.5	0	0	0	0	1	1
Duluth, Minn.		0	0	0	0	0	0
Detroit, Mich.		0	0	0	0	0	0
Milwaukee, Wis.		0	<1	<1	0	1	1

---

[1] Dashes indicate no data reported.

50<

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Concentrations in μμc/liter]

Station	Quarter ending Sept. 30, 1960	November 1960					
	Strontium-90	Beta activity			Alpha activity		
		Suspended	Dissolved	Total	Suspended	Dissolved	Total
Hudson River: Poughkeepsie, N.Y.	0.1	0	0	0	----	----	----
Illinois River: Peoria, Ill.	.3	<1	1	2	3	4	7
Kanawha River: Winfield Dam, W. Va.	----	<1	<1	1	0	1	1
Klamath River: Copco, Oreg.	----	1	2	3	0	1	1
Little Miami River: Cincinnati, Ohio	----	0	<1	<1	0	2	2
Mississippi River:							
Red Wing, Minn.	1.4	0	1	1	0	2	2
Dubuque, Iowa	----	0	14	14	1	1	2
East St. Louis, Ill.	----	0	0	0	0	3	3
Cape Girardeau, Mo.	.9	8	12	20	3	3	6
West Memphis, Ark.	----	3	15	18	1	2	3
Delta, La.	----	0	2	2	1	2	3
New Orleans, La.	----	0	1	1	1	2	3
Missouri River:							
Williston, N. Dak.	----	0	2	2	1	5	6
Yankton, S. Dak.	.5	0	0	0	0	7	7
Omaha, Nebr.	----	8	16	24	3	4	7
St. Joseph, Mo.	----	0	4	4	7	6	13
Kansas City, Kans.	----	0	0	0	1	5	6
St. Louis, Mo.	1.2	11	5	16	7	4	11
Ohio River:							
East Liverpool, Ohio	.4	0	0	0	0	1	1
Wheeling, W. Va.	.5	----	----	----	----	----	----
Huntington, W. Va.	----	0	0	0	0	1	1
Cincinnati, Ohio	----	0	0	0	0	0	0
Evansville, Ind.	----	0	0	0	0	1	1
Cairo, Ill.	.4	7	8	15	<1	1	1
Potomac River:							
Williamsport, Md.	----	0	0	0	0	0	0
Great Falls, Md.	----	0	1	1	0	0	0
Red River, North: Grand Forks, N. Dak.	(³)	0	0	0	0	2	2
Red River, South:							
Denison, Tex.	----	24	9	33	9	45	54
Index, Ark.	----	0	0	0	1	4	5
Alexandria, La.	1.1	11	3	14	5	4	9
Rio Grande River:							
Alamosa, Colo.	----	4	0	4	0	2	2
Brownsville, Tex.	.3	4	0	4	----	----	----
Laredo, Tex.	----	11	5	16	4	2	6
Sabine River: Ruliff, Tex.	----	<1	<1	1	1	<1	1
St. Clair River: Port Huron, Mich.	.6	0	0	0	0	1	1
St. Lawrence River: Massena, N.Y.	----	0	0	0	0	1	1
St. Mary's River: Sault Ste. Marie, Mich.	----	0	0	0	0	1	1
Schuylkill River: Philadelphia, Pa.	----	0	0	0	0	0	0
Savannah River:							
Port Wentworth, Ga.	.8	0	50	50	----	----	----
North Augusta, S. C.	----	0	0	0	0	0	0
Snake River:							
Wawawai, Wash.	.5	0	4	4	0	3	3
Weiser, Idaho	----	0	0	0	0	1	1
Susquehanna River:							
Sayre, Pa.	.3	0	4	4	0	<1	<1
Conowingo, Md.	.3	0	0	0	0	1	1
Tennessee River: Chattanooga, Tenn.	.6	0	40	40	0	<1	<1
Yellowstone River: Sidney, Mont.	----	0	0	0	0	11	11

[3] Insufficient sample for analysis.

51<

Monitoring of Water Supplies Around the Nevada Test Site

By contract with the Atomic Energy Commission, the Public Health Service has conducted an offsite monitoring program around the Nevada Test Site (NTS) since 1955. Included in the program have been measurements of radioactivity in water supplies. These data have been reported in the Atomic Energy Commission's 13th, 14th, 18th, and 23rd Semiannual Reports to Congress and by the Public Health Service in the 1957 congressional hearings, "The Nature of Radioactive Fallout and Its Effects on Man."

Figures 1 and 2 summarize gross beta measurements in water supplies located in the NTS offsite area for September–October and November–December 1960.

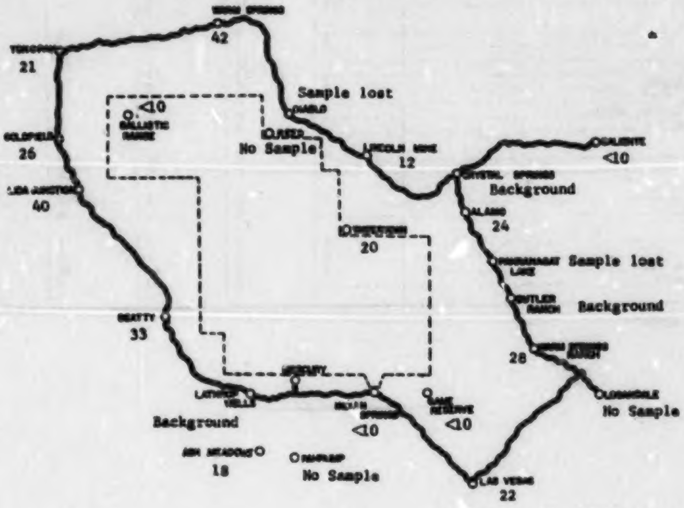
The lower limit of detectability with the equipment used is about 10 micromicrocuries per liter.

TABLE 1.—DESCRIPTION OF WATER SAMPLING POINTS, NEVADA TEST SITE

Location	Source	Population served
Las Vegas	13 wells—650 to 1,260′ depth plus Lake Mead supply.	40,000.
Game Reserve	400′ drilled well	20.
Indian Springs	600′ drilled well	Average 250.
Pahrump	75′ driven well	10–50.
Ash Meadows	Spring 25′ deep	8.
Lathrop Wells	3 wells—600′ deep	Average 15.
Beatty	Spring	550.
Lida Junction	125′ drilled well	3–10.
Goldfield	Spring	Average 200.
Tonapah	2 drilled wells—60′ depth	Average 1,500.
Warm Springs	Multiple springs—no improvement.	10.
Diablo	Well	State highway station.
Lincoln Mine	2 driven wells	3.
Caliente	Springs	Average 10–12.
Crystal Springs	Free flowing spring	0.
Alamo	2 wells—50–67′ deep	Average 175.
Pahranagat Lake	Surface	Not used for domestic purposes.
Butler Ranch	Flowing spring	1.
Warm Spring Ranch.	Flowing spring from earth fault.	Public park with swimming pool.
Logandale	Drilled well	300.
Ballistic Range	Drilled well	10–15.

FIGURE 1—GROSS BETA MEASUREMENTS IN WATER SUPPLIES IN OFFSITE AREAS OF THE NEVADA TEST SITE FOR SEPTEMBER–OCTOBER 1960

[Average concentrations in μμc/liter at time of measurement]

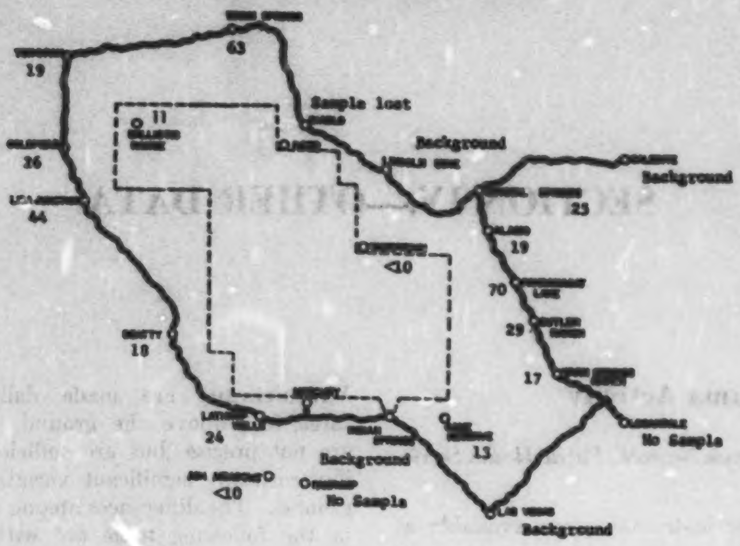


WARM SPRINGS
42
TONOPAH
21
Sample lost
DIABLO
<10
BALLISTIC RANGE
No Sample
LINCOLN MINE
12
CALIENTE
<10
GOLDFIELD
26
CRYSTAL SPRINGS
Background
LIDA JUNCTION
40
ALAMO
24
20
PAHRANAGAT LAKE
Sample lost
BUTLER RANCH
Background
BEATTY
33
WARM SPRINGS RANCH
28
MERCURY
LATHROP WELLS
Background
INDIAN SPRINGS
<10
GAME RESERVE
<10
LOGANDALE
No Sample
ASH MEADOWS
18
PAHRUMP
No Sample
LAS VEGAS
22

52<

FIGURE 2.—GROSS BETA MEASUREMENTS IN WATER SUPPLIES IN OFFSITE AREAS OF THE NEVADA TEST SITE FOR NOVEMBER–DECEMBER 1960

[Average concentrations in $\mu\mu c$/liter at time of measurement]



63
19
Sample lost
11
26
Background
Background
44
23
19
<10
70
29
18
17
24
No Sample
13
Background
<10
No Sample
Background

53<

SECTION IV.—OTHER DATA

External Gamma Activity

Radiation Surveillance Network, Public Health Service

Portable survey instruments are available at stations of the Radiation Surveillance Network for recording levels of external gamma radiation. Measurements are made daily approximately three feet above the ground. These readings are not precise, but are sufficiently accurate to illustrate any significant variations above background. The differences among the values shown in the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY, DECEMBER 1960

Radiation Surveillance Network, Public Health Service

Station location	Average (mr/hr)	Station location	Average (mr/hr)	Station location	Average (mr/hr)
Anchorage, Alaska	0.01	Indianapolis, Ind	0.01	Cincinnati, Ohio	(1)
Fairbanks, Alaska	(1)	Iowa City, Iowa	.07	Oklahoma City, Okla	0.02
Juneau, Alaska	.01	Topeka, Kans	.02	Ponca City, Okla	.04
Phoenix, Ariz	.02	New Orleans, La	.01	Portland, Oreg	.02
Little Rock, Ark	.02	Baltimore, Md	.02	Harrisburg, Pa	.01
Berkeley, Calif	.01	Lawrence, Mass	.03	Providence, R.I	.03
Los Angeles, Calif	.01	Lansing, Mich	.02	Columbia, S.C	.02
Denver, Colo	.02	Minneapolis, Minn	.01	Pierre, S. Dak	.02
Hartford, Conn	.01	Pascagoula, Miss	(1)	Austin, Tex	.01
District of Columbia	.02	Jefferson City, Mo	.01	El Paso, Tex	.02
Jacksonville, Fla	.02	Helena, Mont	.03	Salt Lake City, Utah	.03
Atlanta, Ga	(1)	Trenton, N.J	.02	Richmond, Va	.01
Honolulu, Hawaii	.03	Santa Fe, N. Mex	.04	Seattle, Wash	.02
Boise, Idaho	.02	Albany, N.Y	.02	Cheyenne, Wyo	.02
Springfield, Ill	(1)	Gastonia, N.C	.02	Madison, Wis	.01

[1] No data received.

Factors Contributing to the Occurrence of Radionuclides in Market Milk

St. Louis County Health Department

A discussion of the study of factors contributing to the occurrence of radioactivity in market milk was presented in *Radiological Health Data*, Volume II, No. 3, together with some data on strontium-90 levels in milk and gross radioactivity in animal feeds. The following data, submitted by the St. Louis County Health Department, are further results of their contract with the Research Branch, Division of Radiological Health, Public Health Service. The number of each sampling point in the issue referred to above corresponds to the sampling point number used in the previous issue. The "digestion coefficient" is the average percentage of each nutrient digested in a particular feed. These values are taken from "Feeds and Feeding," by Frank B. Morrison, The Morrison Publishing Co., Ithaca, N.Y.

TABLE 1.—STRONTIUM-90 IN MILK AND HAY

Sampling point	Milk		Hay				
	μμc/ liter	μμc/ cow/ day	Type	μμc/kg	μμc/ cow/ day	Digestion [1] coeff. (percent)	"Digestible" (μμc/ cow/ day)
1	15.9	229.3	Alfalfa	980	5,911	54	3,190
2	15.8	218.8	Red clover and timothy.	282	1,097	[2] 55	603
3	27.4	139.6	Lespedeza	1,840	9,116	50	4,560
4	29.1	267.6	Mixed grasses	1,100	9,977	52	5,190
5	42.6	477.8	Orchard and alfalfa.	1,700	19,374	[2] 54	10,460
6	10.6	96.5	Timothy	715	6,810	45	3,070
7	15.9	169.4	Alfalfa	272	4,984	54	2,690
8	12.2	120.7	Alfalfa	755	10,272	54	5,550
9	44.4	367.7	Red top and timothy	1,071	13,211	[2 3] 40	5,280
10	23.5	223.1	Lespedeza	1,920	14,541	50	7,270
11	14.7	107.2	Red clover and timothy.	450	7,827	[2] 55	4,310
12	20.2	289.0	Alfalfa and prairie.	813	14,749	[2] 48	7,080
13	21.2	169.8	Timothy	1,077	9,769	50	4,880
14	14.0	99.2	No sample				
15	21.8	342.4	No sample				
16	11.0	153.8	No sample				
17	15.3	103.6	Alfalfa	8,370	111,600	54	60,300
18	17.8	173.6	No sample				
19	6.3	54.5	Alfalfa	309	3,347	54	1,810
20	9.8	111.5	Alfalfa	282	2,873	54	1,550
21	22.6	136.5	Mixed grasses and cottonseed hulls.	1,033	9,370	[2] 49	4,590
22	20.1	166.4	Alfalfa	403	4,069	54	2,200
23	29.7	216.3	Red top	996	9,032	31	2,810
24	25.8	92.7	Timothy	1,280	8,950	50	4,480
25	25.4	78.4	No sample				
26	13.0	124.2	Lespedeza and oats	1,183	21,400	[2] 54	11,600
27	12.8	111.2	Alfalfa	1,408	19,208	54	10,400
28	30.8	295.9	Lespedeza	1,940	21,995	50	11,000
29	12.0	111.4	Lespedeza	1,512	7,817	50	3,910
30	22.0	182.2	Lespedeza	1,318	10,879	50	5,440
31	35.4	236.8	Lespedeza	2,020	5,405	50	3,060
			Timothy	270	722	50	
32	35.5	323.1	Lespedeza, red top, timothy.	852	18,161	[2] 44	7,990
33	29.5	361.2	Alfalfa	365	1,778	54	8,490
			Orchard	920	13,936	54	
34	22.6	232.4	Mixed legumes and grasses.	3,570	44,087	[2] 49	21,600
35	14.9	102.7	Ladino	2,290	20,426	[4] 62	12,700
			Oats	380	3,455	58	
36	19.8	126.7	Lespedeza	832	10,394	50	5,200
37	23.9	161.6	Prairie	1,862	17,847	43	7,670
38	23.3	152.8	Mixed grasses	216	2,035	52	1,060
39	22.3	142.9	No sample				
40	24.9	209.6	Oats	482	4,745	58	2,750
41	24.3	276.5	Lespedeza	3,056	17,319	50	8,660
42	17.7	158.7	Prairie	748	5,275	43	2,270
43	18.3	189.2	Alfalfa	1,600	12,572	54	6,790
44	27.0	331.6	Lespedeza	1,161	16,551	50	8,280
45	24.4	238.2	Oat straw, millet and soybean hay.	180	767	[2] 52	399
46	28.4	192.2	Red top and timothy.	1,706	8,099	[2 3] 40	3,250
47	11.5	70.2	Mixed grasses	900	8,490	52	4,420
48	23.0	162.2	Alfalfa	1,426	20,044	54	10,800
49	12.4	88.0	Lespedeza and wheat.	1,098	18,673	[2] 50	9,340
50	7.5	90.2	Red clover	996	28,989	60	17,400
51	18.7	221.2	Red clover	684	15,057	60	9,030
52	22.0	234.2	Red top and timothy.	1,742	24,649	[2 3] 40	9,860
53	23.6	214.8	Lespedeza	1,086	4,934	50	5,820
			Timothy	1,972	6,707	50	
54	17.5	212.1	No sample				
55	11.4	112.8	Prairie	1,052	4,151	43	1,790
56	20.7	125.3	Ladino	1,800	27,184	[4] 62	16,900
57	16.5	159.6	Alfalfa	537	2,922	54	1,580
58	9.0	52.2	Lespedeza	231	1,571	50	786
59	15.6	100.1	Alfalfa, ladino, and orchard.	800	9,136	[2 4] 57	5,210
60	17.5	105.1	Alfalfa	794	8,888	54	4,800
61	19.1	34.8	Lespedeza	582	3,222	50	1,610
62	24.2	132.1	Mixed grasses	1,300	11,791	52	6,130
63	22.4	[illegible]	Mixed grasses	2,585	17,585	52	9,140
64	20.1	174.6	Oats	257	1,229	58	713
65	37.9	344.9	Mixed grasses	1,298	9,545	52	4,960
66	12.1	132.1	Lespedeza	2,160	19,509	50	9,800

[1] The digestion coefficient used is the average of the digestion coefficients of the protein, fat, fiber, and nitrogen-free extract obtained from table I in the appendix to the 22d edition of Frank B. Morrison's *Feeds and Feeding* (pp. 1000 to 1070).

[2] The digestion coefficient used is the average of the appropriate values for each of the hays used.

[3] The red top digestion coefficient is derived from the value for mature and weathered western prairie hay, since the two have similar average total compositions (p. 1015).

[4] The Ladino digestion coefficient is derived from the digestion coefficients for Fescue plus Ladino and Fescue (p. 1009).

Strontium-90 Content of Bone in the St. Louis and Nevada Test Site Areas

Research Branch, Division of Radiological Health, Public Health Service

The study of the uptake and retention of strontium-90 in human populations is a vital phase in the proper assessment of the radionuclide hazard to man. Since Sr^{90} is a "bone seeking" fission product, one measure of body burden which has been used extensively is the concentration in human bone expressed in micromicrocuries per gram of calcium. The Public Health Service and the Atomic Energy Commission have initiated large-scale bone-sampling programs in order to estimate the current body burden of Sr^{90}.

The St. Louis and Nevada Test Site areas have been singled out by the Public Health Service as being of primary interest.[1] The levels of Sr^{90}

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[1] The Public Health Service bone-sampling program in the NTS area is supported by the AEC.

in milk for the St. Louis area have been consistently higher than those for other stations in the raw milk sampling program. Bones were collected from this area to determine whether the higher level of Sr^{90} in milk would in any way be reflected by Sr^{90} levels in bones of individuals living in this area. It was also recognized that the residents in the vicinity of the Nevada Test Site (NTS) may have been subject to an increased amount of radiation due to fallout from nuclear weapon testing.

At the present time, a total of 126 bone samples has been collected and analyzed (73 from St. Louis and 53 from the NTS areas) over a time period extending from July 1959 to July 1960.

For previous articles on strontium-90 content of human bone, refer to *Radiological Health Data*, Volume 1, No. 2, page 32, and Volume II, No. 1, page 41.

Comparisons of Group Means

The results grouped by age and area are shown in table 1 below.

TABLE 1.—COMPARISON OF STRONTIUM-90 IN HUMAN BONE IN THE ST. LOUIS AND NTS AREAS, 1959–60

Group	St. Louis Area			NTS Area		
	Size of group	Mean (μμc/gm Ca)	95% confidence limits for mean	Size of group	Mean (μμc/gm Ca)	95% confidence limits for mean
Stillborn	8	1.2	1.0–1.4	7	0.6	0.3–0.9
Newborn	9	2.2	1.3–3.1	16	2.0	1.3–2.7
Children 1–5	14	2.3	1.3–3.3	7	1.8	.5–3.1
Children 6–20	14	1.3	0.7–1.9	10	.9	.7–1.2
Adults	25	0.3	.2– .4	13	.4	.2– .6

In general, two types of comparisons can be made from this table. First, the two areas do not vary significantly from each other except for the stillborn group where the St. Louis mean is significantly higher. Second, if the differences between the age groups are examined, a statistically significant difference between the children and adults is nearly always detected (one exception is the stillborn group from the NTS area). However, the confidence intervals are so large that it is not possible to find any significant differences between other age groups. It may be noted that an increase in the size of the newborn and children 1–5 and 6–20 groups would lead to smaller confidence limits which would enable one to detect differences between the groups. The bone-sampling scheme is being expanded with this in mind. Although other bone data are scarce for 1959–60, the means in table 1 agree fairly well with the predicted 1959 averages of Kulp, et al.[1] It would seem, then, that the samples of bone from the St. Louis and NTS areas are not significantly higher in Sr^{90} than those for the rest of the U.S. population.

Strontium-90 Body Burden Predictions

The problem of finding the best theoretical distribution to apply to the Sr^{90}/Ca ratio in bones has been investigated by Libby (1957) and Dahl (1957) with only moderate success. The limited amount of data available made it somewhat difficult to find empirical justification for any postulated mathematical model. Libby has assumed the distribution to be "normal," while Dahl has felt that it is better described as a "log normal" distribution.[2]

The importance of knowing what distribution law describes the experimental data is related to the problem of predicting how many people in a population can be expected to exceed a given burden, or equivalently, what burden will be exceeded by a given small proportion of the population. Any evaluation of risk involves an estimate of the proportion of people having an unusually high skeletal burden. Dahl felt that the experimental data were more nearly log normal and compared the fit using the normal and log normal distributions on a small group of experimental data.

There are three important considerations which lead to the use of "log-normal" theory in fitting this type of experimental data:

1. The observed frequencies are skewed to the left (i.e., there is a greater proportion of people with a smaller burden than would be expected in a normally distributed population).

2. The observed distribution has a relatively long right tail (i.e., there are more people who have higher burdens). Thus, the use of the conventional normal theory leads to seriously underestimating the number of people who would be expected to be found in the higher burden category.

3. In very broad theoretical terms, the log normal model assumes that each ingestion of a

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[1] Kulp, J. L., Schulert, A. R., and Hodges, E. J., "*Strontium-90 in Man—IV*" *Science*, *132* (1960), 448.

[2] Libby, W. F., "Distribution and Effects of Fallout," *Bulletin of the Atomic Scientists*, *XIV* (1958), 27.

radionuclide produces an increment in total skeletal burden which is proportional to the burden present at the time of ingestion. The normal distribution only assumes that equal ingestions produce equal increments to total burden regardless of the amount already present in the bone.

The normal and log normal distributions are compared in figures 1, 2, and 3, using data compiled by Kulp, et al.,[1] and the Public Health Service data from the NTS and St. Louis areas. Estimates are given of the body burden which will be exceeded by a small proportion (1 person per 10,000) of the population under the 2 assumptions.

The method used was to plot the data on arithmetic probability and log probability paper which tranforms normal and log normal populations, respectively, into straight lines. Thus, a good fit is indicated by a close conforming of the experimental points to a straight line. Figures 1 to 3 indicate the goodness of fit of the experimental data. In the case of the Western single bone data as presented by Kulp, et al.,[1] the log normal distribution seems to do a much better job of fitting the points, although slight sigmoidal tendencies still exist. Therefore, it appears that the log normal distribution is more satisfactory in the empirical sense.

At the present time, the small amount of Public Health Service data shown in figures 2 and 3 fails to yield conclusive evidence as to the superiority of the log normal distribution. Figures 1, 2, and 3 show the skeletal concentration along the vertical axis and the proportion of people exceeding the given concentration along the horizontal axis. Table 2 below shows the expected concentration which will be exceeded by 1 person per 10,000 in the population at risk for the normal and log normal assumptions.

TABLE 2.—CONCENTRATION TO BE EXCEEDED BY 1 PERSON PER 10,000 UNDER NORMAL AND LOG NORMAL ASSUMPTIONS

Origin of bone sample	Distribution assumption	Strontium-90 concentration (μμc/gm Ca)
Western single bone	Normal	0.8
	Log normal	1.6
St. Louis-NTS (adults)	Normal	1.3
	Log normal	2.4
St. Louis-NTS (children ages 1-20)[1]	Normal	4.9
	Log normal	20.0
Maximum permissible skeletal concentration for population (ICRP).		67.0

[1] Age groups 1-5 and 6-20 years pooled.

It can be observed that the concentrations predicted by the log normal distribution are higher and thus represent a more conservative approach. In addition, the curvilinear trend at the right tail under the log normal assumption is downward so that a linear extrapolation will overestimate rather than underestimate the proportion of people with very high concentrations. Of course, the normal and log normal are not the only distributions which may provide reasonable models for the population. As a larger volume of data become available, other theoretical distributions are being tested to insure the application of the best model to the population prediction problem.

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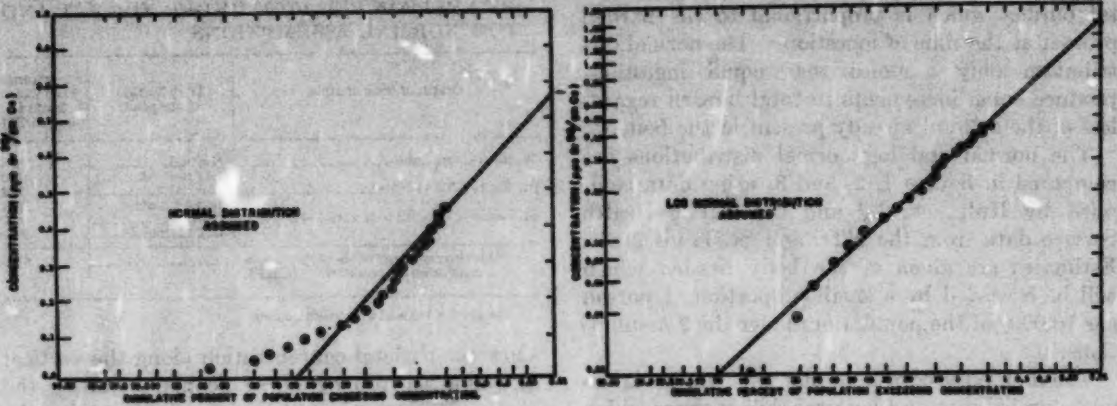
[1] Kulp, J. S., Schulert, A. R., and Hodges, E. J., "*Strontium-90 in Man—IV*" *Science*, *132* (1960), 448.

FIGURE 1.—WESTERN SINGLE BONE CONCENTRATION* (ADULTS), 1957



*See reference 1. (Best fit straight line with more weight given to tail observations.)

FIGURE 2.—ST. LOUIS AND NTS BONE CONCENTRATIONS (CHILDREN), 1959–60

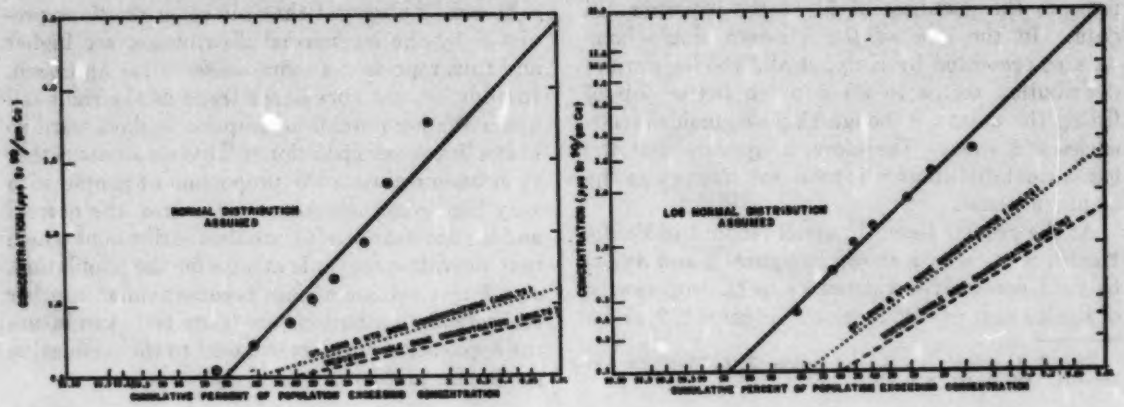
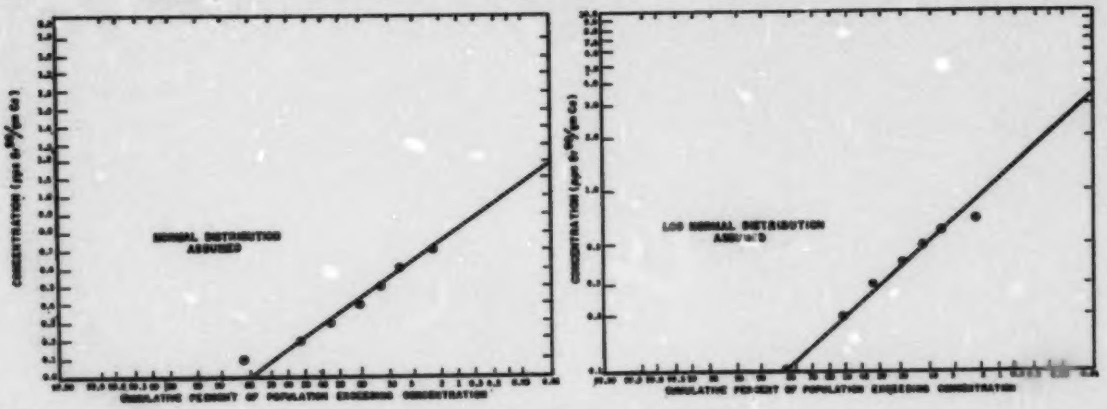


FIGURE 3.—ST. LOUIS AND NTS BONE CONCENTRATIONS (ADULTS), 1959–60



ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission is providing data on environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis. The data are from routine monitoring programs where operations are of such a nature that environmental surveys are required.

Radiological Health Data, Volume I, Nos. 8 and 9; and Volume II, Nos. 1, 2, 3, and 4 contain summaries for 17 installations. Summaries follow for the Hanford Works, the National Reactor Testing Station, and the Savannah River Plant.

Hanford Atomic Products Operation

General Electric Co., Richland, Wash., Issued December 1960

Introduction

During operation of the plutonium production and research facilities at Hanford, controlled amounts of radioactive wastes are released to the atmosphere, ground, and to the Columbia River. The protection of persons living in the neighborhood of the controlled area from radiation exposure attributable to Hanford sources is one of the responsibilities in the operation of the Hanford facilities.

The release of radioactive wastes and environmental radiation levels are summarized for the calendar year 1959 and the first and second quarters of 1960.

Water

The eight production reactors, whose locations are shown in figure 1, contribute radionuclides to the Columbia River water which is used as reactor coolant. More than 60 radionuclides have been identified in the reactor effluent water, and their relative abundance is illustrated in figure 2. Other Hanford facilities do not contribute measurably to the quantity of radionuclides in the river.

Many of the radionuclides in the reactor effluent water are short lived and decay rapidly after formation in the reactors. A gross decay curve, which illustrates this characteristic, is reproduced as figure 3. In addition to radioactive decay, radionuclides are removed from the river water by such mechanisms as silting and uptake by river biota.

Pasco and Kennewick are the nearest cities downstream which treat Columbia River water for use as a public water supply. Finished water (drinking water) from each of the water treatment plants was sampled weekly and analyzed for individual radionuclides or in some cases groups of radionuclides such as the rare earths. Untreated river water at the Pasco pumping plant inlet was also sampled and analyzed weekly. The results of this sampling are summarized in tables 1 and 2.

The finished water of other communities near the plant having sources of water supply other than the Columbia River was periodically sampled and analyzed. Richland, Benton City, Ringold, and Riverview farms are a few of these locations. During a 10-year sampling period, a higher concentration of natural uranium has been noted in the water from Benton City wells than in the water from wells of other local communities.

For the mixture of nuclides present in the river and in finished waters, the gastrointestinal (GI) tract is the organ of major interest. During the period covered by this report, the Pasco population was exposed to less than 7 percent of the maximum permissible concentration in water (MPC$_w$) for the GI tract. The MPC$_w$ for the population

FIGURE 1.—LOCATION MAP, HANFORD ATOMIC PRODUCTS OPERATION

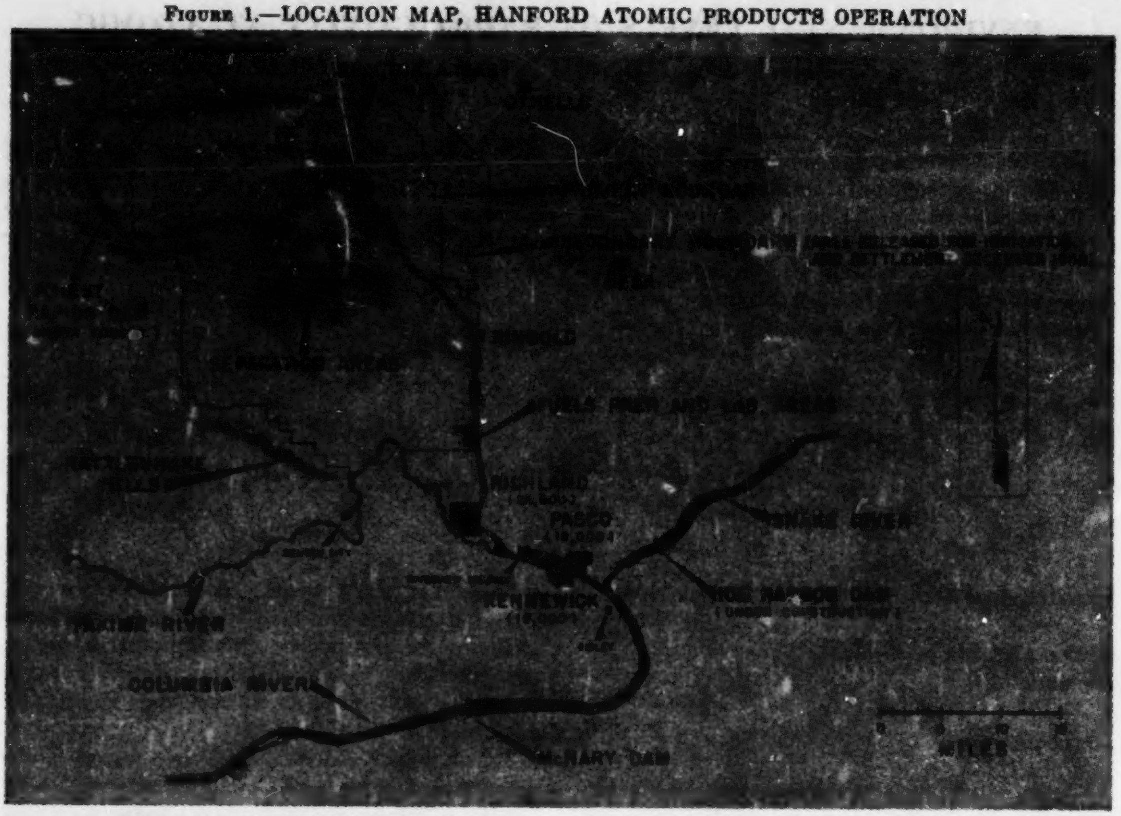
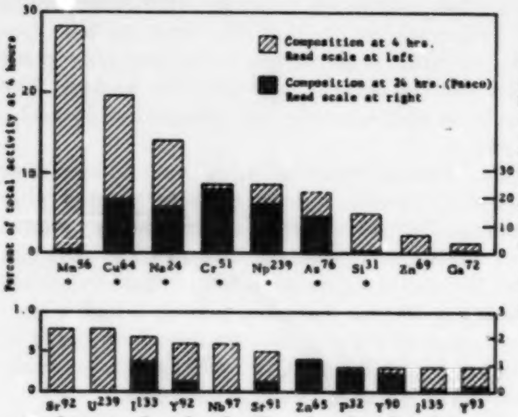

RICHLAND
PASCO
KENNEWICK
SNAKE RIVER
ICE HARBOR DAM
(UNDER CONSTRUCTION)
YAKIMA RIVER
COLUMBIA RIVER
McNARY DAM
MILES

FIGURE 2.—ISOTOPIC COMPOSITION OF REACTOR EFFLUENT 4 HOURS AND 24 HOURS AFTER IRRADIATION

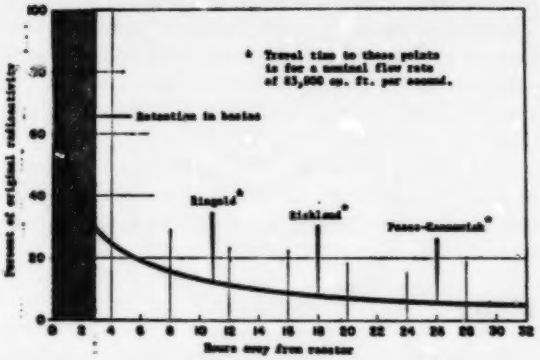


In addition to the isotopes shown above, which contribute about 98 percent of the activity 4 hours after irradiation, trace amounts of the following have also been found.

Eu-152
Sm-153
W-187
La-141
Nd-149
La-140
I-132*
Eu-157
Ba-140*
Mo-99
Sm-156
Sc-46*
Cd-115
Ce-143
I-131*
Ce-141
Pr-142
C-14
Nd-147
Ca-45*
Ag-111
Y-91
Fe-59*
Sr-89*
Mn-54
Zr-95
Pm-149
Eu-156
Pr-145
Pm-151
Co-60
Pr-143
Ru-103
Sc-47
Sr-90*
Cs-137
Sr-85
U-238*
Pu-239*
Ac-227
Po-210*

* Routine measurements are made on these isotopes

FIGURE 3.—REDUCTION IN RADIOACTIVITY OF REACTOR EFFLUENT WITH TIME



residing in the neighborhood of a controlled area is one-tenth that given for continuous occupational exposure by NBS Handbook No. 69. Solubility in GI tract and body fluids is assumed. An exposure to less than 2 percent of the MPC_w for the GI tract is estimated for Kennewick residents. The average contribution of several radionuclides to the exposure of the tract would be as illustrated in figure 4.

60<

TABLE 1.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN DRINKING WATER

[Average concentrations in $\mu\mu c$/liter]

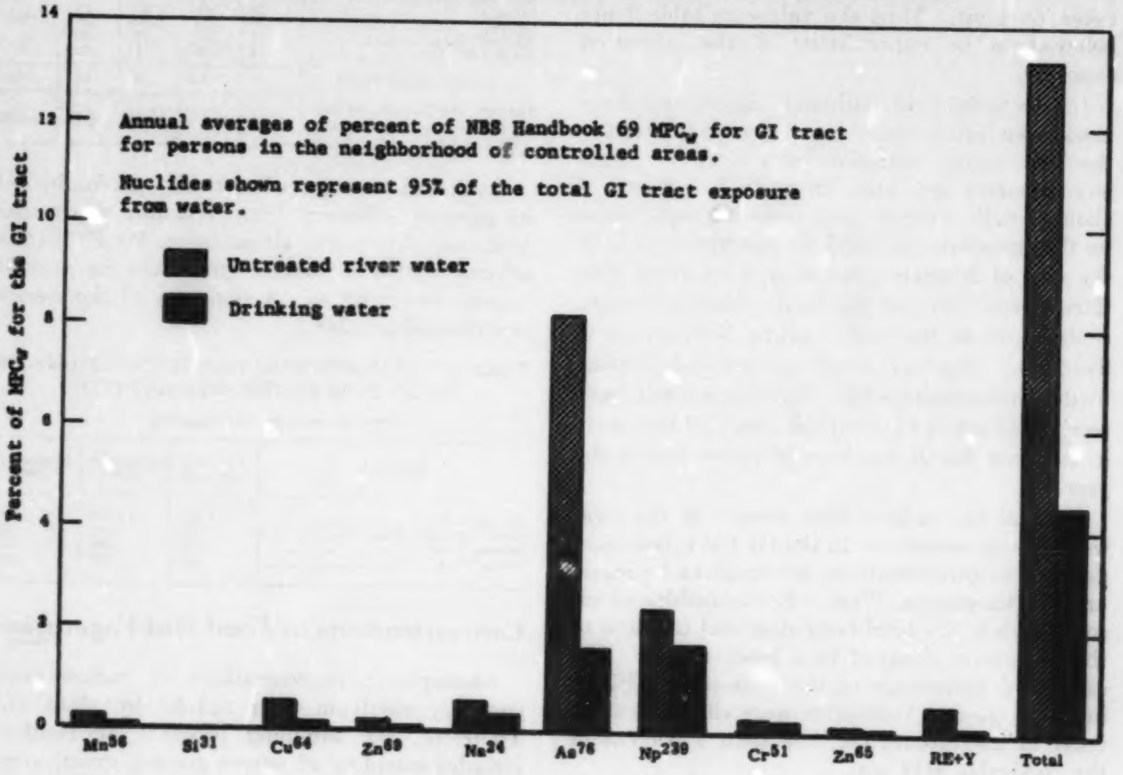
Period	Number samples	Rare earths plus γ	Na^{24}	P^{32}	Cr^{51}	Cu^{64}	Zn^{65}	Zn^{69m}	As^{76}	Sr^{89+90}	Sr^{90}	Np^{239}
Pasco												
1959	52	23	575	35	2,710	340	86	24	340	4.5	0.51	1,500
1st quarter 1960	13	115	359	126	5,770	220	202	12	490	5.1	.37	2,010
2d quarter 1960	11	56	873	21	2,650	500	113	22	210	3.2	.20	1,260
Kennewick												
1959	49	29	151	18	2,080	230	24	18	180	1.0	.26	350
1st quarter 1960	9	33	93	18	3,000	110	25	10	75	.5	.18	290
2d quarter 1960	10	34	150	11	1,580	150	16	14	60	.5	.16	65

TABLE 2.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN COLUMBIA RIVER WATER

[Average concentrations in $\mu\mu c$/liter]

Period	Number samples	Rare earths plus γ	Na^{24}	P^{32}	Cr^{51}	Cu^{64}	Zn^{65}	Zn^{69m}	As^{76}	Sr^{89+90}	Sr^{90}	Np^{239}
Pasco												
1959	52	213	1,140	156	4,210	1,620	206	104	1,460	5.3	0.64	3,250
1st quarter 1960	14	690	1,200	1,281	7,190	1,640	417	94	1,510	9.9	.44	4,340
2d quarter 1960	11	606	1,660	130	3,190	2,690	246	222	1,200	3.7	.26	1,790
Vancouver												
1959	8	----------	----------	31	2,120	----------	32	----------	----------	----------	----------	179
1st quarter 1960	6	----------	----------	59	2,750	----------	114	----------	----------	----------	----------	97
2d quarter 1960	5	----------	----------	41	1,466	----------	90	----------	----------	----------	----------	196

FIGURE 4.—PERCENT OF MPC_w FOR THE GI TRACT FOR SELECTED RADIONUCLIDES IN COLUMBIA RIVER WATER AND SANITARY WATER AT PASCO, WASHINGTON—1959



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The estimated dose of other organs through water intake is substantially less than that for the GI tract. Some indicative values are compared with the GI tract exposure in table 3.

TABLE 3.—1959 AVERAGE PERCENTAGE MPC_w

Location	Type	Percent of $\frac{1}{10}$ MPC_w		
		Bone	Total body	GI
Pasco	Inlet water (Columbia River water).	1.6	0.9	15
Pasco	Drinking water	.9	.5	5
Kennewick	Drinking water	.6	.2	2
Vancouver	Columbia River water	.7	.2	-------

Several radionuclides contribute to the exposures shown in amounts below the analytical detection limits. In this case, where analytical data permit, the concentrations in the reactor effluent, river depletion rates and river flow data are used to estimate the concentration at a given location. If insufficient data are available for this computation, it is then assumed the radionuclide was present in the concentration represented by the detection limit. Thus the values in table 3 are believed to be upper limits of the estimated exposure.

In the vicinity of Richland, Pasco, and Kennewick, ionization chambers were used to measure the penetrating radiation in the river. Such measurements indicated an annual exposure of about 60 milliroentgens (mr) excluding background for the operators of a ferryboat just upstream from the city of Richland, assuming they spent one-third of their time on the boat. Since the major contributors to the dose, such as Na^{24}, are short lived, the exposure from recreational boating further downstream is less. Swimmers would have received about 15 mr from this source, if they were in the river for as much as 60 hours during the year.

Most of the radionuclides present in the river water which contribute to the GI tract dose have decayed to concentrations too small to be measured at Vancouver, Wash. Radionuclides which contribute to the total body dose and the dose to the bone have decayed to a lesser extent. The calculated percentage of the respective MPC_W's in river water at Vancouver were all of the same order of magnitude; i.e., less than 1 percent of the applicable MPC_W's.

Air

Filter papers from air-sampling stations are changed daily by cooperating agencies. These filter papers are counted for total beta activity. Radioanalyses of filter papers for individual radionuclides is not a routine procedure. However, such an analysis was performed in 1959, during the third quarter. Filter papers from each of 13 locations were grouped for this analysis. Table 4 is a summary of these results corrected for radioactive decay to July 15, 1959. The fact that the concentrations in table 4 are very nearly the same for all locations is evidence that these radionuclides are from fallout.

TABLE 4.—CONCENTRATION OF RADIONUCLIDES ON FILTER PAPERS—THIRD QUARTER 1959

[Average concentrations in $\mu\mu c/m^3$]

Location	Zr^{95}–Nb^{95}	Cs^{137}	Ru^{106}	Ce^{144}–Pr^{144}	Zn^{65}
Benton City, Wash	0.14	0.047	0.16	0.29	--------
Richland, Wash	.13	.029	.17	.25	--------
Kennewick, Wash	.19	.054	.21	.38	--------
Pasco, Wash	.17	.053	.23	.34	0.011
Yakima, Wash	.17	.027	.15	.27	--------
Walla Walla, Wash	.14	.029	.15	.29	--------
Meacham, Oreg	.10	.031	.11	.26	.009
Lewiston, Idaho	.16	.035	.27	.37	--------
Spokane, Wash	.14	.029	.16	.31	--------
Boise, Idaho	.20	.044	.27	.50	--------
Seattle, Wash	.09	.025	.088	.18	.006
Klamath Falls, Oreg	.14	.032	.22	.30	--------
Great Falls, Mont	.14	.037	.15	.25	.011
Average concentration	.15	.0363	.180	.307	.009
Percent MPC_{air} for critical organ	0.001	0.002	0.004	0.01	0.0002

Radiodine has characteristically predominated in gaseous effluents from Hanford separation facilities. Therefore, air sampling for I^{131} in the atmosphere is a routine procedure in several nearby communities. A summary of the results is presented in table 5.

TABLE 5.—ATMOSPHERIC CONCENTRATIONS OF I^{131} AT PERIMETER COMMUNITIES

[Average concentrations in $\mu\mu c/m^3$]

Location	Calendar year 1959	1st quarter 1960	2d quarter 1960
Richland, Wash	0.074	0.046	0.016
North Richland, Wash	.070	.052	.020
Benton, Wash	.157	.056	.010
Pasco, Wash	.129	.027	.012

Concentrations in Food and Vegetation

Atmospheric concentrations of radionuclides generally result in their uptake by plant life. Therefore, the sampling program at Hanford includes sampling of native grasses, grain, vege-

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tables, fruits, alfalfa, milk, and other materials from the biosphere such as jackrabbit thyroid. These data are not summarized here but will be published separately in a subsequent issue of *Radiological Health Data.*

Conclusions

It is concluded from the data that the estimated exposure of persons residing in the neighborhood of the Hanford controlled area approximates 10 to 15 percent of the applicable limits recommended by the National Committee on Radiation Protection.

Hanford's contribution to environmental exposure through atmospheric paths is considerably less than that due to fallout from nuclear detonations. Atmospheric contributions are small compared to the contribution through water effluents.

National Reactor Testing Station

Health and Safety Division, Atomic Energy Commission, Idaho Falls, Idaho, Issued December 1960 and February 1961

Environmental levels of radioactivity at the National Reactor Testing Station (NRTS) have been reported in *Radiological Health Data,* Volume I, No. 9, and Volume II, No. 2. The following report presents the data for the third and fourth quarters, 1960.

Safe operation of the National Reactor Testing Station, without radiation hazard to the public or the environment, continued during the third and fourth quarters.

Table 1 summarizes data for radioactivity in water, air, rabbit bones, and milk sampled at more than 200 locations on, near, and within 115 miles radius of the NRTS.

Figure 1 details the locations and types of sampling. It will be noted that air monitoring is concentrated to the northeast, and water monitoring is to the southwest of the NRTS. This is in accordance with the prevailing wind direction and the local underground water gradient for this region. Periodic evaluations of the program are made, and adjustments in location and sampling frequency will be made in subsequent reports.

The minimum detection limit used in connection with iodine-131 in milk is now 200 μμc/liter. This reflects an improvement in the analytical method, which increases the sensitivity of this procedure by a factor of 5 over that previously used.

TABLE 1.—RADIOACTIVITY IN WATER SUPPLIES

[Average concentrations in μμc/liter]

Type of supply	Number of stations	Sampling frequency	3d quarter 1960			4th quarter 1960		
			Number of samples	Alpha	Beta	Number of samples	Alpha	Beta
Offsite ground water	29	Bimonthly	50	<3.1	<150	28	<3.1	<150
Onsite production well water	22	Weekly	200	<3.0	<160	208	3.0	<150

TABLE 2.—GROSS BETA RADIOACTIVITY IN OFF-SITE AIR

Period 1960	Sampling frequency	Number of stations	Number of samples	Average concentrations (μμc/m³)
3d quarter	Weekly	10	138	1.3
4th quarter	Weekly	10	117	1.4

TABLE 3.—STRONTIUM-90 IN JACKRABBIT BONES[1]

Location	Number stations	Sampling frequency	3d quarter 1960		4th quarter 1960	
			Number samples	Average concentration (μμc/gm Ca)	Number samples	Average concentration (μμc/gm Ca)
Perimeter	10	Quarterly	9	16	11	9
Offsite	10	Quarterly	25	15	20	13

[1] Analyses are for the previous quarter.

TABLE 4.—OFFSITE MILK MONITORING FOR IODINE-131

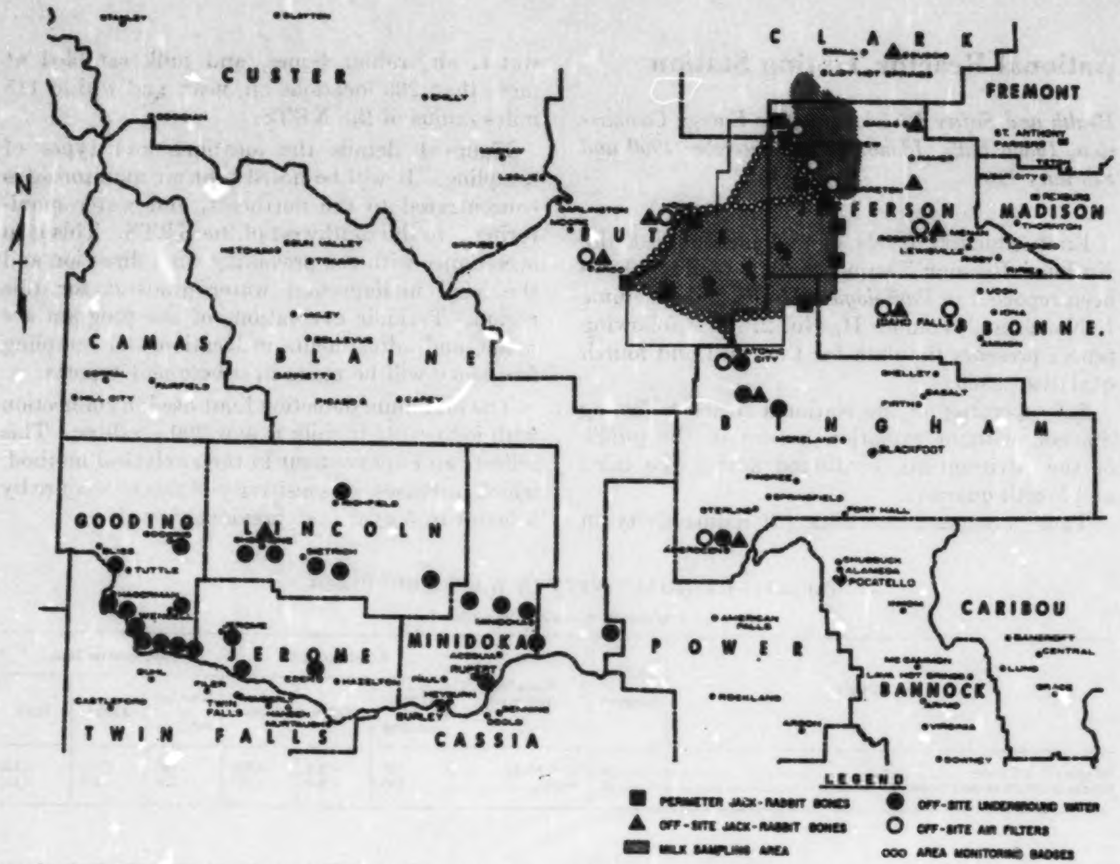
Period (1960)	Sampling frequency	Number stations	Number samples	Average concentration (μμc/liter)
3d quarter	Monthly	30	317	<-200
4th quarter	Monthly	30	348	<210

TABLE 5.—OFFSITE FILM BADGE MONITORING

[Dose in mrem/90 days]

Period (1960)	Sampling frequency	Number stations	Number samples	Beta	Gamma
3d quarter	Monthly	118	108	10	10
4th quarter	Monthly	118	340	10	20

FIGURE 1.—ENVIRONMENTAL MONITORING STATIONS, NATIONAL REACTOR TESTING STATION


N
CUSTER
CLARK
FREMONT
BUTTE
JEFFERSON
MADISON
BONNEVILLE
CAMAS
BLAINE
BINGHAM
GOODING
LINCOLN
JEROME
MINIDOKA
POWER
CARIBOU
BANNOCK
TWIN FALLS
CASSIA
IDAHO FALLS
BLACKFOOT
POCATELLO
AMERICAN FALLS
ARCO
RUPERT
SHOSHONE
LEGEND
PERIMETER JACK-RABBIT BONES
OFF-SITE JACK-RABBIT BONES
MILK SAMPLING AREA
OFF-SITE UNDERGROUND WATER
OFF-SITE AIR FILTERS
OOO AREA MONITORING BADGES

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Savannah River Plant

E. I. du Pont de Nemours Co., Aiken, S.C., Issued February 9, 1961

Environmental levels of radioactivity at the Savannah River Plant for 1959 and the first quarter of 1960 were reported in *Radiological Health Data*, Volume 1, No. 9. The following report presents a summary of the data for the second and third quarters of 1960.

The Savannah River Plant maintains a continuous monitoring program to determine the concentrations of radioactive materials in a 1,200-square-mile area outside the plant perimeter. Included in this area are parts of Aiken, Barnwell, and Allendale Counties in South Carolina, and Richmond, Burke, and Screven Counties in Georgia. This program, initiated in 1951 prior to startup of the plant, is carried out by the Health Physics Section of the Du Pont Co. The purposes of the program are to measure the background at the site, to determine the magnitude and origin of any radioactivity above the natural levels and, of primary interest, to insure that any radioactive materials released to the environment by plant operations are below the Radioactivity Concentration Guides (RCG) for large populations specified by the Federal Radiation Council.

A basic principle of plant operations is total containment of radioactive waste. Although some varied low level gaseous and liquid wastes are disbursed within the environment in controlled releases, the disbursal is adequate to insure that the concentration is well below the RCG levels. The RCG is a benchmark against which environmental contamination levels can be evaluated. The survey data presented in this report provide information which is useful both to measure the effectiveness of plant controls and as evidence of the strict adherence to the recommended RCG levels.

Very sensitive instruments, which can detect traces of radioactive materials several orders of magnitude below that of hazard significance, are used to determine the levels of radioactivity in the environs. Frequently, radioactivity could not be detected in environmental samples. In such instances, a minimum amount that can be accurately detected by the analysis is used in determining the average concentrations. These values (sensitivity of analysis) are presented with the data. In most cases, possible radioactivity contributed by the plant was either so small it was less than that which exists naturally or it was obscured by fallout which resulted from nuclear weapons testing. Since radioactive materials contributed by each of these sources cannot be readily separated or interpreted in terms of origin, all are included in the reported concentrations.

Atmospheric Monitoring

A comprehensive surveillance of levels of radioactivity in the atmosphere was carried out by weekly analyses of air and rain water samples collected continuously at 13 monitoring stations, including 5 locations at the plant perimeter. These stations, forming two concentric circles around the plant, are spaced so that a significant plant release of radioactivity to the air would be detected regardless of prevailing wind conditions (see fig. 1). Four continuous air monitoring stations were installed during the report period at locations approximately 100 miles from the plant. These distant stations, operated at Savannah and Macon, Ga., and Columbia and Greenville, S.C., serve as "reference points" for determining background levels of radioactivity in air. The location of the 100-mile-distant stations in relation to the Savannah River Plant are shown in figure 2. An average level of radioactivity at the plant perimeter substantially higher than that observed at the 25-mile and 100-mile radii would be indicative of a plant contribution, since weapons debris arriving from distant test sites would be widespread and more evenly disbursed. Small differences in average radioactivity levels, however, are attributed both to nonuniformity of fallout and to statistical variation of the analyses. Table 1 summarizes the air monitoring data.

TABLE 1.—GROSS RADIOACTIVITY IN AIR

[Average concentrations in $\mu\mu c/m^3$]

Location	2d quarter 1960			3d quarter 1960		
	Alpha	Non-volatile beta	Radio-iodine	Alpha	Non-volatile beta	Radio-iodine
Plant perimeter	0.0025	0.24	0.04	0.0009	0.09	<0.04
25-mile radius	.0011	.18	.04	.0007	.07	<.04
100-mile radius	-------	-------	-------	.0012	.06	-------
Percent of RCG at plant perimeter	6.3	0.24	0.01	2.2	0.09	0.03
Sensitivity of analysis	.0003	.013	0.04	0.0004	0.008	0.04

FIGURE 1.—SAMPLE COLLECTION STATIONS, SAVANNAH RIVER PLANT

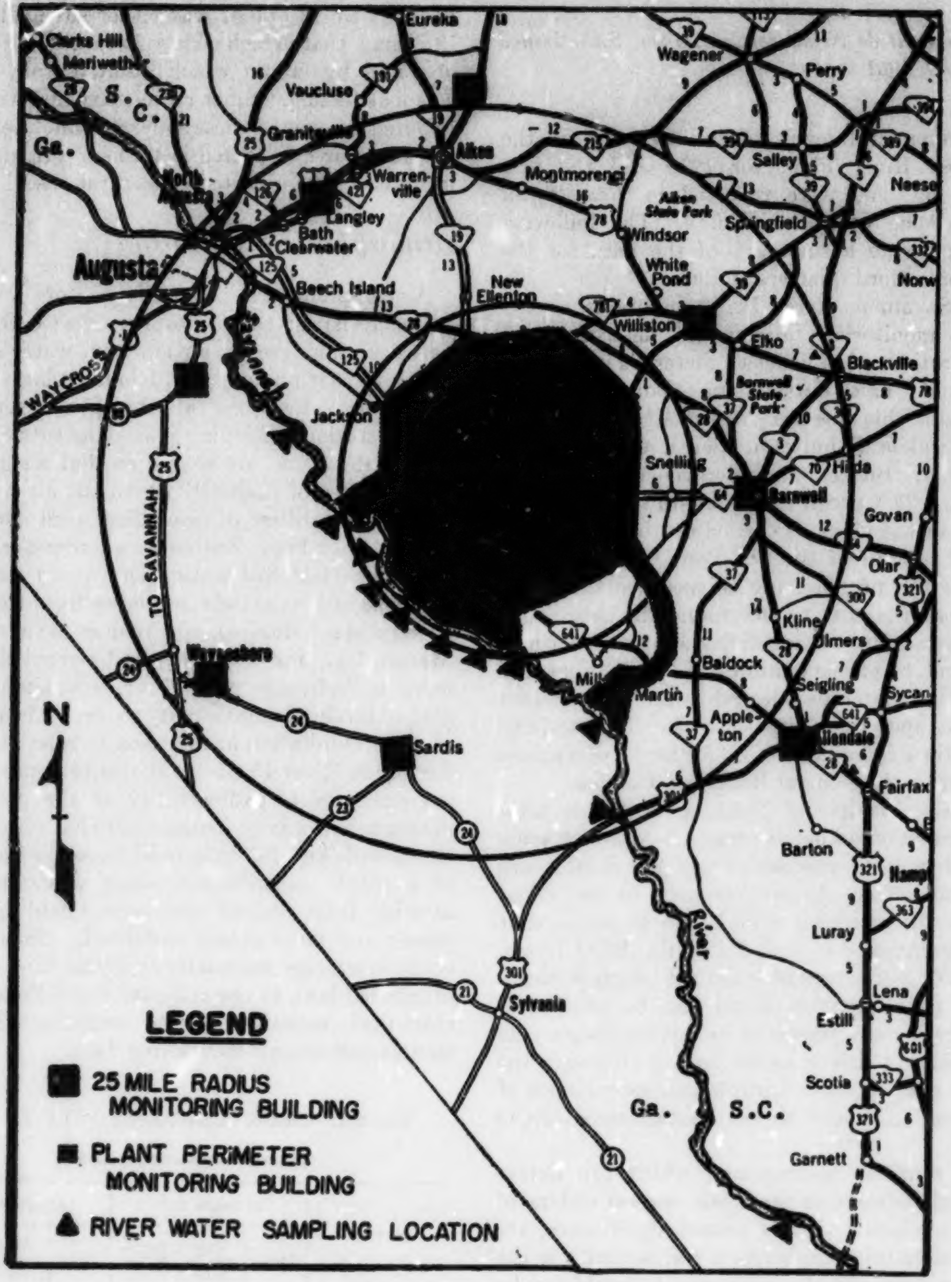
LEGEND
25 MILE RADIUS MONITORING BUILDING
PLANT PERIMETER MONITORING BUILDING
RIVER WATER SAMPLING LOCATION
N
Augusta
North Augusta
Aiken
Barnwell
Allendale
Waynesboro
Sardis
Sylvania
Williston
Jackson
New Ellenton
Beech Island
Langley
Bath
Clearwater
Warrenville
Graniteville
Vaucluse
Eureka
Clarks Hill
Meriwether
Montmorenci
Windsor
White Pond
Aiken State Park
Wagener
Perry
Salley
Springfield
Neese
Norway
Elko
Blackville
Barnwell State Park
Snelling
Hilda
Govan
Olar
Kline
Ulmers
Baldock
Seigling
Martin
Millett
Appleton
Sycamore
Fairfax
Barton
Hampton
Luray
Lena
Estill
Scotia
Garnett
Savannah River
TO SAVANNAH
WAYCROSS
Ga.
S.C.

FIGURE 2.—DISTANT AIR MONITORING STATIONS, SAVANNAH RIVER PLANT

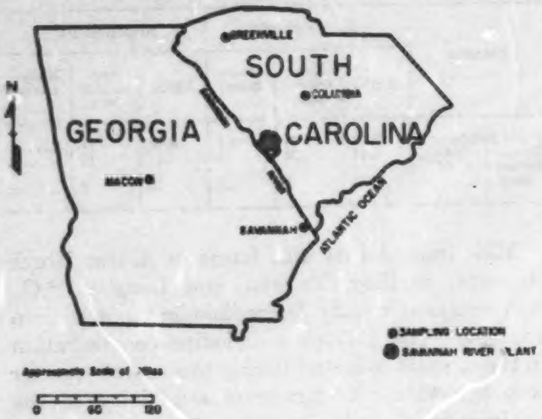

TABLE 2.—GROSS RADIOACTIVITY IN RAINWATER

[Average concentrations in μμc/liter]

Location	2d quarter 1960			3d quarter 1960		
	Alpha	Nonvolatile beta	Radioiodine	Alpha	Nonvolatile beta	Radioiodine
Plant perimeter	0.7	50	14	0.6	28	<7
25-mile radius	.6	50	15	.4	20	<8
100-mile radius	--------	--------	--------	--------	--------	--------
Percent of RCG [1] at plant perimeter	7.0	1.7	0.7	6.0	0.9	1.0
Sensitivity of analysis	0.1	7	15	0.2	4	--------

[1] Assuming use as drinking water.

The average concentration of atmospheric radioactivity during the second quarter of 1960 generally showed an increase over 1959 and first quarter 1960 values. The third quarter showed a marked reduction in values. A release of airborne radioactivity from the manufacturing area during the 7-day period ending June 15, 1960, was evident at one monitoring station near the plant perimeter but not at any offsite monitoring locations. This single release increased the average concentrations of alpha and nonvolatile beta emitters at the plant perimeter during the report period, with no hazards to personnel.

The increase during the second quarter in the nonvolatile beta emitters in air, as reflected by the concentrations at the 25-mile radius, was due to the large-scale upper air motions that caused maximum deposition of nuclear weapons test debris from the stratospheric reservoir during the spring months.

The environmental radioiodine was so low during the third quarter that no radioiodine was found in the 642 environmental samples (air, rainwater, and vegetation) analyzed using sensitive radiochemical procedures.

Environmental Gamma Radiation Levels

Continuous measurements were taken at each of 13 monitoring buildings, as shown in figure 1, to determine the gamma radiation level. Plant operations were found to have had no measurable effect on the gamma radiation levels. The average dose rates at the perimeter locations and at the 25-mile-radius locations were no higher than those expected from natural sources alone. These values, almost identical with those obtained during previous quarters, are consistent with external gamma radiation levels recorded at all of of stations of the Public Health Service Radiation Surveillance Network in March 1960.

Water Monitoring

The communities in the vicinity of the Savannah River Plant obtained their drinking water from deep wells or small surface streams. The results of public water samples collected monthly from 14 surrounding towns which are shown in table 3 are essentially the same as those observed prior to startup of the Savannah River Plant before 1951.

TABLE 3.—RADIOACTIVITY IN PUBLIC WATER SAMPLES

[Average concentrations in μμc/liter]

Analysis	2d quarter 1960			3d quarter 1960		
	Sensitivity of analysis	Concentration	Percent RCG	Sensitivity of analysis	Concentration	Percent RCG
Alpha	0.1	1.0	10	0.2	0.7	7
Nonvolatile beta	7	7	.2	4	6	.2

The close agreement of these data with the results obtained prior to startup shows no effect due to plant operations and only a slight increase due to nuclear weapons fallout in water supplies that utilize surface streams.

Savannah River water was sampled continuously at one location immediately upstream from the plant and at one location downstream from

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the plant (at the Highway 301 crossing). The results of weekly analyses of these samples were supplemented by analyses of "grab" samples collected each week at eight river locations along the plant boundary and at one location 60 miles downstream from the plant (Stokes Bluff Landing).

Quarterly average concentrations of radioactivity in Savannah River water as shown in table 4 indicate that plant operations contribute small amounts of radioactivity to the river, but the resulting concentrations are far below RCG values.

TABLE 4.—RADIOACTIVITY IN SAVANNAH RIVER WATER

[Average concentrations in μμc/liter]

Location	2d quarter 1960				3d quarter 1960			
	Alpha	Nonvolatile beta	H^3	Sr^{90} [1]	Alpha	Nonvolatile beta	H^3	Sr^{90} [2]
3 miles above plant	0.3	7	4,000	0.4	0.2	6	4,000	0.3
At plant boundary	.5	21			.3	19		
10 miles below plant	.4	26	8,000	.7	.2	27	9,000	.5
Percent of RCG at 10 miles downstream	4.0	0.9	0.3	2.1	2.0	0.9	0.3	1.5
Sensitivity of analysis	0.2	7	4,000	0.1	0.2	4	4,000	0.1

[1] These averages include samples collected during March, April, and May, 1960.

[2] These averages include samples collected during June, July, and August, 1960.

Vegetation and Food Monitoring

The sampling program included collection of vegetation from 14 locations along the plant perimeter and at 14 locations along the 25-mile-radius route. Bermuda grass was selected for sampling because of its importance as a pasture grass for dairy herds and because of its availability during all seasons of the year.

The average concentrations of radioactivity in vegetation are shown in table 5. The fact that the concentrations are very nearly the same at the plant perimeter and along the 25-mile radius is evidence that plant contributions are negligible and that the radioactivity being measured is attributed to fallout and natural sources. An apparent downward trend of radioactivity was observed in vegetation as shown by the results. The decreased alpha activity is consistent with previously observed seasonal variations, while the beta radioactivity reflects decreased fallout.

TABLE 5.—RADIOACTIVITY IN BERMUDA GRASS SAMPLES

[Average concentrations in μμc/gm dry weight]

Location	2d quarter 1960			3d quarter 1960		
	Alpha	Nonvolatile beta	Radio iodine	Alpha	Nonvolatile beta	Radioiodine
Plant perimeter	0.12	23	0.7	0.10	14	
25-mile radius	.13	20	.7	.11	12	
Sensitivity of analysis	.05	4	.7	.1	2	

Milk from dairies and farms in Aiken, North Augusta, Snelling, Talatha, and Langley, S.C., was analyzed weekly for radioiodine and tritium content. The average radioiodine concentration in the samples collected during the second quarter was less than the minimum sensitivity of the analysis which is equivalent to 25 percent of the RCG. The average tritium concentration during this quarter was approximately 5,000 micromicrocuries per liter. This concentration is approximately 2 percent of the RCG.

An improved radioiodine analysis of milk samples, adopted during the third quarter in 1960, allowed detection of concentrations equivalent to 0.5 percent of the RCG. Even with this substantially lower detection limit, the quarterly average radioiodine concentration in milk samples was less than the minimum sensitivity of the analyses (9 μμc/liter). The results for analyses of milk samples for tritium during the third quarter were unchanged from those of the second quarter.

Quarterly determinations of strontium-90 content were performed on milk produced locally. In addition to the sampling points mentioned previously, milk from local farms and dairies in Williston and Brogdon, S.C., and Sylvania, Ga., was sampled and analyzed. Average concentrations detected in milk samples during the second quarter were 11.5 μμc/liter and during the third quarter, 14.5. These concentrations are attributed entirely to the accumulation of strontium-90 fallout from previous nuclear weapons tests. The results are slightly less than those reported by the Public Health Service Raw Milk Sampling Station at Atlanta, Ga.[1]

Milk collected from farms where only one or two cows produce for domestic consumption contained more strontium-90 than milk collected from local dairies. Such differences are attributed

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[1] *Radiological Health Data*, Volume I, No. 7, October 1960.

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to different methods of feeding, the dairy herd being partially stall fed with nonfodder supplements and the "family cow" subsisting almost entirely on pasture grass.

The determination of radioactivity concentrations in algae is important because they are well-known concentrators of specific radioactive materials and because of their relationship in the food chain of aquatic organisms. Indigenous algae, primarily green (*Vaucheria*) and blue-green (*Phormidium*), were collected weekly upstream from, adjacent to, and downstream from the plant. The results are shown in table 6. These concentrations show some correlation with those in the plant effluent as it discharges into the river, since the average concentrations of nonvolatile beta emitters in algae upstream were less than that downstream.

TABLE 6.—RADIOACTIVITY IN SAVANNAH RIVER ALGAE

[Average concentrations in μμc/gm dry weight]

Location	Nonvolatile beta emitters	
	2d quarter 1960	3d quarter 1960
3 miles upstream from plant	25	35
At plant boundary	128	65
10 miles downstream	104	60

Fish, predominantly bream and catfish, were collected weekly above, adjacent to, and below the plant. The average levels of radioactivity observed are presented in table 7. The quarterly average nonvolatile beta concentrations measured in the edible portion (flesh) showed no plant concentrations are attributed to naturally-occurring potassium-40.

TABLE 7.—RADIOACTIVITY IN FISH FLESH

[Average concentrations in μμc/gm wet weight]

Location	Nonvolatile beta emitters	
	2d quarter 1960	3d quarter 1960
3 miles upstream from plant	4	3
At plant boundary	5	4
60 miles downstream from plant	4	4

General Conclusion

The concentrations of radioactive materials found in the environs of the Savannah River Plant during the second and third quarters of 1960 were, like the first quarter, too low to be distinguished from natural background or from bomb debris from past weapons tests. Exceptions are minor radioactivity concentrations having no health significance in the water and aquatic organisms of the Savannah River.

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U.S. GOVERNMENT PRINTING OFFICE: 1961

RADIOLOGICAL HEALTH DATA

MONTHLY REPORT **JUNE 1961**

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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CORRECTION FOR THE MAY ISSUE—SECTION I.—AIR

Technical difficulties during the programing of radon and thoron measurements for electronic data processing resulted in the publication of incorrect figures on table 2 on page 209 of last month's report, *Radiological Health Data*, volume II, No. 5. The table below presents the revised data.

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SECTION I.—AIR

Radiation Surveillance Network

Division of Radiological Health, Public Health Service

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in levels of environmental radioactivity due to fallout from nuclear weapons tests. Although no nuclear tests have been conducted by the United States since 1958, the program has proved sufficiently valuable that it has been extended to a year-round basis. Currently, it consists of 46 stations at urban locations (see fig. 1) operated by State and local health department personnel with 2 stations operated by Public Health Service personnel.

Figure 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS

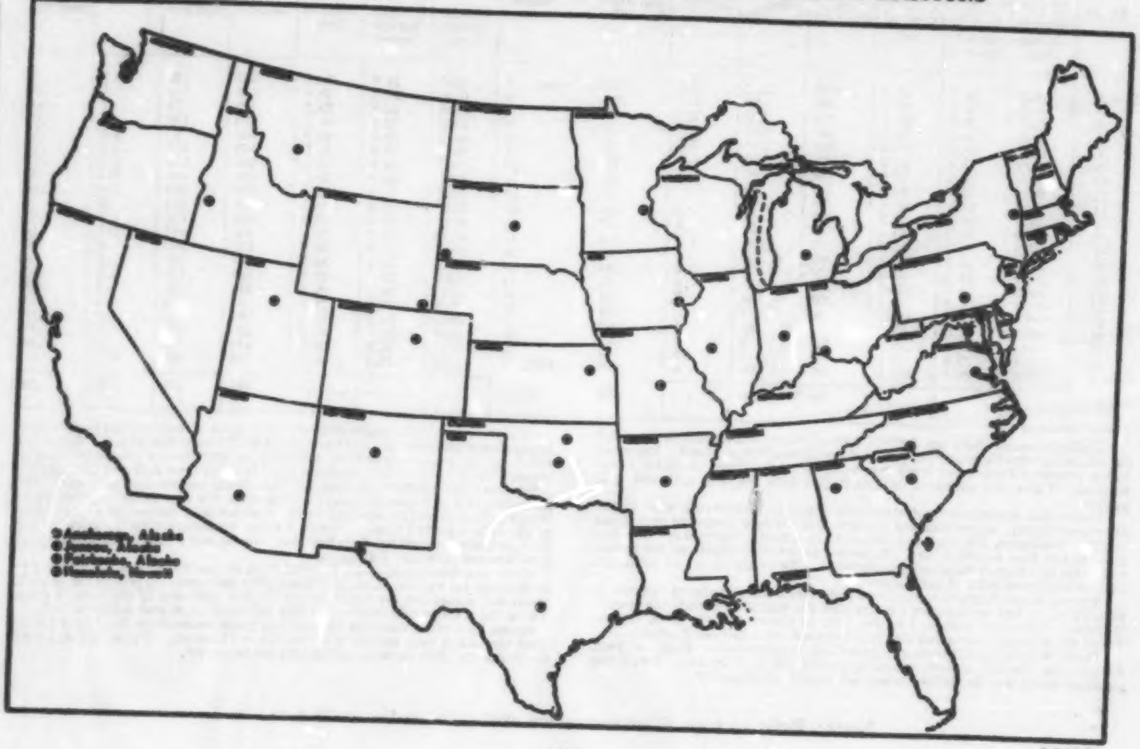

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TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR—GROSS BETA DETERMINATIONS

Public Health Service Radiation Surveillance Network, January 1961

Station location	Number samples	Maximum (μμc/m³)	Minimum (μμc/m³)	Weighted average (μμc/m³)
Anchorage, Alaska	21	<0.10	<0.10	<0.10
Fairbanks, Alaska	21	.16	<.10	<.11
Juneau, Alaska	22	.11	<.10	<.10
Phoenix, Ariz	6	.22	<.10	<.13
Little Rock, Ark	21	.12	<.10	<.10
Berkeley, Calif	20	.15	<.10	<.11
Los Angeles, Calif	21	.26	<.10	<.13
Denver, Colo	16	.16	<.10	<.11
Hartford, Conn	23	.10	<.10	<.10
District of Columbia	20	.12	<.10	<.10
Jacksonville, Fla	17	.17	<.10	<.10
Atlanta, Ga	17	.21	.03	.06
Honolulu, Hawaii	21	<.10	<.10	<.10
Boise, Idaho	16	.44	<.10	<.16
Springfield, Ill	9	<.10	<.10	<.10
Indianapolis, Ind	20	<.10	<.10	<.10
Iowa City, Iowa	21	.11	<.10	<.10
Topeka, Kans	23	.12	<.10	<.10
New Orleans, La	6	<.10	<.10	<.10
Baltimore, Md	19	<.10	<.10	<.10
Lawrence, Mass	21	<.10	<.10	<.10
Lansing, Mich	20	<.10	<.10	<.10
Minneapolis, Minn	8	<.10	<.10	<.10
Pascagoula, Miss	20	0.21	<0.10	<0.13
Jefferson City, Mo	21	.12	<.10	<.10
Helena, Mont	21	.11	<.10	<.10
Trenton, N.J	0	----	----	----
Santa Fe, N. Mex	21	.16	<.10	<.13
Albany, N.Y	21	<.10	<.10	<.10
Gastonia, N.C	18	.15	<.10	<.10
Cincinnati, Ohio	21	.20	.06	.07
Oklahoma City, Okla	20	.13	<.10	<.10
Ponca City, Okla	21	.18	<.10	<.10
Portland, Oreg	21	.28	<.10	<.13
Harrisburg, Pa	14	<.10	<.10	<.10
Providence, R.I	20	<.10	<.10	<.10
Columbia, S.C	5	<.10	<.10	<.10
Pierre, S. Dak	7	.11	<.10	<.10
Austin, Tex	20	.12	<.10	<.10
El Paso, Tex	19	.26	<.10	<.16
Salt Lake City, Utah	21	.21	<.10	<.12
Richmond, Va	20	.12	<.10	<.10
Seattle, Wash	19	.11	<.10	<.10
Madison, Wis	22	<.10	<.10	<.10
Cheyenne, Wyo	9	<.10	<.10	<.10

TABLE 2.—RADON AND THORON MEASUREMENTS

Radiation Surveillance Network, Public Health Service, Station at Cincinnati, Ohio, Dec. 2, 1960–Jan. 3, 1961

Date	Continuous sample collection			Radon [a] a.m. (μμc/m³)	Radon-thoron [b] p.m. (μμc/m³)	Thoron [c] (μμc/m³)	Beta [d] activity (μμc/m³)
	Sample change time	Sample period (hours)	Volume (m³)				
Dec. 2	0822	24.1	27.5	250	----	2.3	0.03
5	0822	72.0	84.0	340	80	4.9	.07
6	0815	23.9	30.1	250	120	2.4	.19
7	0835	24.3	28.6	300	160	1.7	.14
8	0821	23.7	27.3	290	160	2.1	.14
9	0814	23.9	28.2	300	160	1.4	.07
12	0842	72.5	86.8	110	90	1.5	.05
13	0835	23.0	28.2	210	40	.6	.06
14	0823	23.8	28.8	190	60	.8	.05
15	0827	24.0	29.2	160	140	.9	.05
16	0830	23.9	29.1	110	150	.9	.07
19	0825	72.1	85.9	210	130	1.3	.06
20	0823	23.9	28.6	240	100	.4	.02
21	0825	24.0	28.5	120	300	.6	.00
22	0823	24.0	28.9	240	150	.6	.13
23	0836	24.2	30.1	250	120	.7	.09
27	0808	95.5	112.8	40	170	.5	.03
28	0807	24.0	29.3	220	30	.4	.03
29	0812	24.1	28.9	430	190	.6	.04
30	0812	24.0	29.0	170	210	.8	.12
Jan. 3	0810	96.0	113.9	190	160	.5	.04
Av	----	----	----	230	136	1.2	.07

[a] Radon concentrations are derived from alpha measurements determined immediately after the sampling period (24 to 72 hours) has ceased. Reported radon concentrations have been corrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±18 and ±37 μμc/m³.

[b] Radon concentrations are derived from alpha measurements made in the afternoon (3 p.m.) approximately 7 hours after the new sampling period has begun. Therefore, the reported values were actually determined one day prior to the date reported here. Reported radon concentrations are uncorrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±9 and ±26 μμc/m³.

[c] Thoron concentrations are derived from alpha measurements referred to in footnote (a) but are counted 7 hours after the sampling period has ceased. Reported values are corrected to the time of removal of the filter holder. Twice the standard deviation (2σ) falls between ±0.2 and ±0.7 μμc/m³.

[d] Gross beta concentrations are based on measurements made at least 4 days after the end of each sampling period (24 to 72 hours). Twice the standard deviation (2σ) fallbe tween ±0.02 and ±0.10 μμc/m³.

Radiation Surveillance Network, Public Health Service, Station at Cincinnati, Ohio, Jan. 4–Feb. 1, 1961

Date	Continuous sample collection			Radon [a] a.m. (μμc/m³)	Radon-thoron [b] p.m. (μμc/m³)	Thoron [c] (μμc/m³)	Beta [d] activity (μμc/m³)
	Sample change time	Sample period (hours)	Volume (m³)				
Jan. 4	0810	24.0	28.8	350	120	0.9	0.12
5	0826	24.2	29.0	470	310	1.1	.20
6	0816	23.8	28.7	140	170	.7	.03
9	0822	72.1	86.7	110	100	.5	.07
10	0815	23.9	28.8	590	80	2.2	11
11	0808	23.9	28.9	440	110	2.0	.04
12	0817	24.1	28.8	790	180	3.5	.13
13	0828	24.2	28.5	800	290	3.7	.07
16	0826	71.9	86.1	170	390	1.0	.08
17	0817	23.9	28.5	120	240	.9	.13
18	0815	23.9	27.9	340	120	1.5	.05
19	0824	24.1	29.1	300	140	1.5	.13
20	0817	23.9	28.8	160	100	.9	.00
23	0827	72.1	84.7	300	160	.9	.04
24	0812	23.7	28.0	320	120	.5	.01
25	0820	24.1	29.6	340	70	.6	.00
26	0816	23.9	28.4	150	80	.4	.14
27	0823	24.3	29.2	180	180	.4	.06
30	0816	71.7	82.6	220	160	.8	.07
31	0815	24.0	28.5	440	90	.9	.03
Feb. 1	0902	23.8	28.0	700	210	1.6	.08
Av	----	----	----	347	161	1.26	.08

[a] Radon concentrations are derived from alpha measurements determined immediately after the sampling period (24 to 72 hours) has ceased. Reported radon concentrations have been corrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±19 and ±40 μμc/m³.

[b] Radon concentrations are derived from alpha measurements made in the afternoon (3 p.m.) approximately 7 hours after the new sampling period has begun. Therefore, the reported values were actually determined 1 day prior to the date reported here. Reported radon concentrations are uncorrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ±16 and ±37 μμc/m³.

[c] Thoron concentrations are derived from alpha measurements referred to in footnote (a) but are counted 7 hours after the sampling period has ceased. Reported values are corrected to the time of removal of the filter holder. Twice the standard deviation (2σ) falls between ±0.20 and ±0.68 μμc/m³.

[d] Gross beta concentrations are based on measurements made at least 4 days after the end of each sampling period (24 to 72 hours). Twice the standard deviation (2σ) falls between ±0.02 and ±0.10 μμc/m³.

NOTE: Refer to page ii for correction of the December 1960 data.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. Field measurements enable the operator to estimate the amount of beta activity of particulates in air at the station five hours after collection by comparison with a known source using a portable survey meter. The filters are then forwarded to the central laboratory of the Radiation Surveillance Network in Washington, D.C., for a more refined measurement using a thin window proportional counter. The stations located at Atlanta, Ga., and Cincinnati, Ohio, conduct their own laboratory analyses.

Air samplers are in operation at the 46 stations on an average of 70 percent of the week. Air is drawn through a cellulose carbon-loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples. About 85 percent of the stations collect samples of precipitation which are sent to Washington, D.C., for analysis. Values are now below limits of detection by present instrumentation.

Tables 1 and 2 summarize the data for January 1961.

Radioactivity Measurements In Air

U.S. Naval Research Laboratory

Radioactivity measurements of air-filter samples collected at various sites near the 80th meridian (west) are made by the U.S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during January 1961 is presented in table 1, and the radioactivity profile for the same month is shown in figure 1. Radioactive debris from the French nuclear test of December 27, 1960, was detected on two filters exposed at Miraflores, Panama (collections of January 6–9 and 9–11, 1961) and on a single filter exposed at San Juan, P.R. (collection of January 6–9, 1961). None was detected at any of the other collection sites. The presence of fresh fission products on the above filters was confirmed by measurement of the rate of decay of the gross beta activity.

Figure 1 now illustrates the data plotted in semilogarithmic coordinates. Previously the data were presented in rectangular coordinates with the abscissa expressed in disintegrations per minute per cubic meter. The concentrations in table 1 are expressed in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

TABLE 1.—DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION

U.S. Naval Research Laboratory, January 1961

[dpm/m³]

Day	Punta Arenas, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal	San Juan, P.R.	Mauno Loa, Hawaii	Miami, Fla.	Washington, D.C.	Moosonee, Ontario, Canada	Thule, Greenland
1	0.03	0.15	0.12	0.01	0.08	0.06	0.14	----------	0.03	0.08	0.11	0.07	0.13
2	.03	.15	.12	.01	.08	.05	.14	0.14	.03	.08	.11	.07	.13
3	.04	.09	.06	.01	.13	.07	.14	.14	.10	.14	.16	.08	.34
4	.04	.09	.06	.08	.13	.08	.14	.14	.10	.14	.16	.08	.34
5	.03	.09	.10	.06	.04	.07	.09	.11	.12	.16	.18	.11	.10
6	.03	.09	.10	----------	.04	.08	.09	.11	.12	.16	.18	.11	.10
7	.01	.08	.10	.01	.03	.06	3.38	1.59	.08	.16	.12	.11	.10
8	.01	.08	.10	.01	.03	.05	3.38	1.59	.08	.16	.12	.11	.10
9	.01	.08	.10	.03	.03	.04	3.38	1.59	.08	.16	.12	.11	.10
10	.01	.12	.09	.04	.03	----------	2.91	.14	.09	.20	.10	.11	.09
11	.01	.12	.09	.04	.03	.10	2.91	.14	.09	.20	.10	.11	.09
12	.004	.10	.10	.03	.02	----------	.15	.06	.12	.11	.14	.10	.09
13	.004	.10	.10	.06	.02	.10	.15	.06	.12	.11	.14	.10	.09

TABLE 1.—DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION—Con.

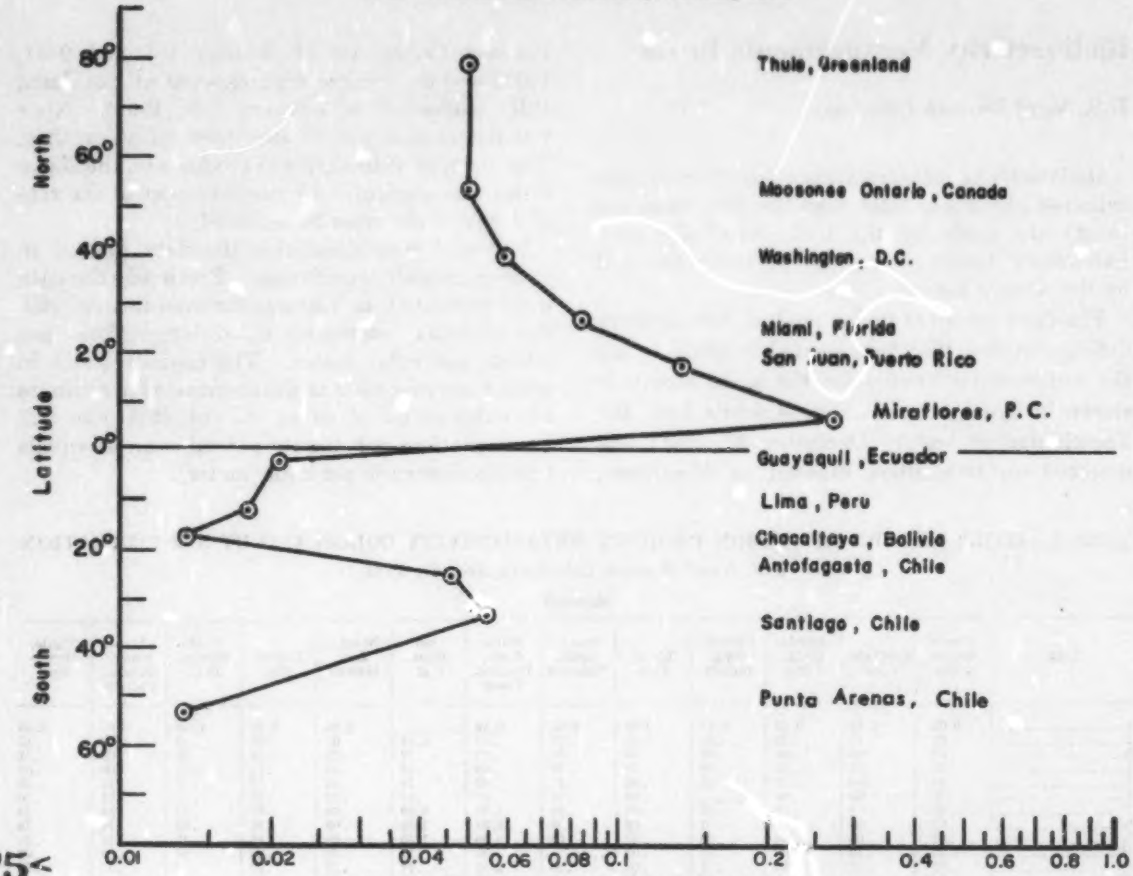
U.S. Naval Research Laboratory, January 1961—Continued

[dpm/m³]

Day	Punta Arenas, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal	San Juan, P.R.	Mauno Loa, Hawaii	Miami, Fla.	Washington, D.C.	Moosonee, Ontario, Canada	Thule, Greenland
14	0.05	0.08	0.11	0.06	0.08	0.10	0.12	0.06	0.08	0.11	0.13	0.12	0.07
15	.05	.08	.11	.05	.08	.10	.12	.05	.08	.11	.13	.12	.07
16	.05	.08	.11	.04	.08	.08	.13	.06	.08	.11	.13	.12	.07
17	.04	.15	.08	.04	.02	.07	.10	.06	.08	----------	.06	.17	.07
18	.04	.16	.08	.03	.02	.07	.10	.06	.08	----------	.06	.17	.07
19	.01	.14	.07	.05	.04	.06	.04	.06	.04	.43	.10	.26	.05
20	.01	.14	.07	.08	.04	.05	.04	.06	.04	.42	.10	----------	.05
21	.03	.13	.08	.02	.01	.03	.05	.06	.05	.19	.10	.09	.05
22	.02	.13	.08	.05	.01	.03	.05	.06	.08	.19	.10	.09	.06
23	.03	.13	[illegible]	.04	.01	.06	.06	.06	.08	.19	.10	.09	.06
24	.07	.15	.12	.05	.02	.04	.07	.06	.08	.21	.13	----------	.06
25	.07	.15	.12	.01	.03	.01	.07	.06	.08	.21	.13	----------	.13
26	.09	.13	.13	.01	.04	.01	.07	.06	.08	.17	.11	----------	.15
27	.09	.13	.13	.01	.04	.01	.07	.06	[illegible]	.17	.11	----------	.17
28	.01	----------	----------	----------	.02	.03	.10	.07	.09	.09	.20	----------	.17
29	.01	----------	----------	----------	.02	.03	.10	.07	.08	.09	.20	----------	.11
30	.01	----------	----------	----------	.03	.03	.10	.07	.08	.09	.20	----------	.11
31	.05	----------	----------	----------	----------	.04	.13	.10	.08	.20	.19	----------	.11
Mean value	.03	.12	.09	.03	.04	.05	.60	.30	.08	.18	.13	.11	.11

FIGURE 1.—PROFILE OF BETA ACTIVITY

Average Measurements of Surface Air at Stations Near the 80th Meridian (West), U.S. Naval Research Laboratory, January 1961



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Atmospheric Levels of Fission Product Gross Beta Activity Collected in Italy

Division of Biology and Sanitary Protection, Italian National Committee for Nuclear Energy

The following tables present the results of atmospheric gross beta measurements made at ground level throughout Italy during the third and fourth quarters of 1959, and the first and second quarters of 1960.

These tables were compiled from data which appeared in report number BIO/03/60 entitled, "Data on Environmental Radioactivity, Collected in Italy (July–December 1959)," and report number BIO/24/60 entitled, "Data on Environmental Radioactivity, Collected in Italy (January–June 1960)." These reports were issued in March and September 1960, respectively, by the National Committee for Nuclear Energy.

Figure 1 shows the approximate geographic locations of the sampling stations referred to in tables 1 and 2.

TABLE 1.—FISSION PRODUCT GROSS BETA ACTIVITY IN AIR AT GROUND LEVEL, 1959

[Average concentration in $\mu\mu c/m^3$]

Station	3d quarter	4th quarter
Bari	0.56	0.08
Bologna	.64	.09
Casaccia	(1)	.14
Elmas	.73	.09
Ferrania	1.02	.11
Genova	.89	.08
Ispra	.54	.11
Lat[illegible]	[3] .56	.24
L[illegible]	.57	.16
[illegible]	.70	.11
[illegible]	.77	.10
[illegible]	[3] 1.39	.19
[illegible]	.67	.12
[illegible]	.57	.11
[illegible]	.65	.10
[illegible]	.92	.14
[illegible]	[3] .43	.04
[illegible]	.61	.08
[illegible]	.63	.11
[illegible]	.89	.08
S. [illegible] Milanese	.05	.09
S. [illegible]	.52	.17
S. Piero a Grado	.62	.28
Trieste	.64	.09
Verbania Pallanza	.63	.09
Vigna Di Valle	.56	.09

[1] No data reported.
[2] Mean is based on measurements made in September.
[3] Mean is based on measurements made in July and September.

TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN AIR AT GROUND LEVEL, 1960

[Average concentrations in $\mu\mu c/m^3$]

Station	1st quarter	2d quarter
Alghero	0.09	0.15
Bari	.08	.14
Bologna	.07	.12
Brindisi	[1] .10	.13
Casaccia	0.11	0.17
Cozzo Spadaro	[1] .12	.16
Elmas	.40	.14
Ferrania	.04	.05
Garigliano Foce	[1] .14	.29
Genova	.07	.12
Ispra	.12	.13
Latina	1.67	1.73
Livorno	.07	.07
Messina	.10	.17
Milano "A"	.04	.10
Milano "B"	.09	.13
Milano "C"	.07	.16
Monte Cimone	.12	.16
Monte S. Angelo	.08	.13
Monte Scuro	.12	.21
Monte Terminillo	.08	.16
Napoli "A"	.08	.14
Napoli "B"	.11	.18
Padova	.06	.12
Palermo	.10	.13
Pian Rosà	.36	.20
Resina	.08	.15
Roma (Capannelle)	[1] .05	.10
Saluggia	[1] .08	.15
S. Donato Milanese	.06	.07
S. Giusto	.07	.08
S. Piero a Grado	.10	.09
Trapani (Chinisia)	.09	.16
Trieste	.07	.11
Verbania Pallanza	.10	.11
Vigna Di Valle	.09	.14

[1] Mean is based on measurements made in February and March.

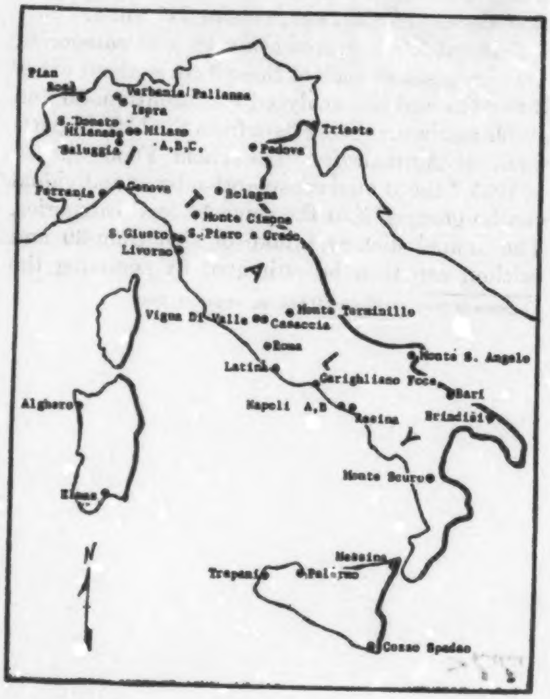
Pian Rosà
Verbania/Pallanza
Ispra
S. Donato Milanese
Milano A,B,C,
Saluggia
Trieste
Padova
Ferrania
Genova
Bologna
Monte Cimone
S. Giusto
S. Piero a Grado
Livorno
Monte Terminillo
Vigna Di Valle
Casaccia
Roma
Monte S. Angelo
Latina
Garighliano Foce
Bari
Alghero
Napoli A,B
Resina
Brindisi
Monte Scuro
Elmas
N
Messina
Trapani
Palermo
Cozzo Spadao

FIGURE 1.—SAMPLING STATIONS FOR THE DETERMINATION OF FISSION PRODUCT BETA RADIOACTIVITY IN AIR AT GROUND LEVEL—ITALY

SECTION II.—FOOD, OTHER THAN MILK

Tri-City Diet Study

Health and Safety Laboratory, U.S. Atomic Energy Commission

The Health and Safety Laboratory is continuing its dietary survey of the strontium-90 and stable calcium levels of individuals living in New York City, San Francisco, and Chicago. The first complete set of results obtained for these cities was reported in HASL–90[1] and presented in *Radiological Health Data*, volume II, No. 4.

Selected foods, representing 19 food catagories, are purchased at each of these 3 cities about every 3 months and are analyzed for strontium-90 and stable calcium. Using data from the U.S. Department of Agriculture, "Household Food Survey of 1955," the annual consumption by an individual can be grouped into the same 19 food categories. The annual dietary intake of strontium-90 and calcium can then be estimated by summing the contributions from each category. Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general. Hence, in the tables that follow, the values shown for food consumption may not be directly related to the original data in the source document.

Tables 1, 2, and 3 present the results obtained from these three cities in the second set of analyses.[2] Some tentative conclusions which may be drawn from the data accumulated to date are:

(*a*) West Coast diets contain less Sr^{90} than East Coast diets,

(*b*) The Sr^{90}/Ca ratio of milk continues to be a good indicator of the ratio for the total diet, although this may not prove to be so at a later time, and

(*c*) The average annual intake of calcium is relatively constant at about 390 grams per year.

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[1] *Quarterly Summary Report*, HASL–90, August 18, 1960.

[2] Data from: *Quarterly Summary Report*, HASL–111, April 1, 1961.

TABLE 1.—STRONTIUM-90 AND CALCIUM LEVELS OF DIET

New York City, June 1960

Food type	Annual consumption (kg/yr)	Calcium		Strontium-90			Food type	Annual consumption (kg/yr)	Calcium		Strontium-90		
		gm/kg original material	gm/year	μμc/kg original material	μμc/gm Ca	μμc/year			gm/kg original material	gm/year	μμc/kg original material	μμc/gm Ca	μμc/year
Whole grain products	11	0.98	10.8	28.2	28.8	310	Fruit juices	19	0.09	1.7	3.0	32.8	57
Refined grain products	37	1.30	48.1	10.2	7.8	377	Fruit—fresh	68	.21	14.3	1.9	9.1	129
Refined grain flour	43	.18	7.7	9.2	51.3	397	Rice	3	.38	1.1	1.0	2.8	3
Milk—liquid	221	1.09	240.9	11.0	10.1	2,431	Eggs	16	.58	9.3	2.0	3.5	32
Potatoes	45	.16	7.2	3.2	20.2	144	Fish—fresh	8	1.10	8.8	.3	.3	2
Macaroni	3	.18	.5	4.6	25.6	14	Fish—shell	1	.73	.8	.5	.7	1
Beans—dried	3	.68	2.0	2.2	3.2	7	Meat	73	.09	6.6	.9	10.5	66
Vegetables—canned	20	.23	4.6	2.9	12.5	58	Poultry	17	.15	2.6	.7	4.4	12
Vegetables—fresh	43	.32	13.8	13.6	42.6	585							
Vegetables—root	17	.32	5.4	5.2	16.3	88	Total			388			4,760
Fruit—canned	26	.05	1.3	1.8	36.4	47							

Averages: 12.3 μμc Sr^{90}/gm Ca; 13.0 μμc Sr^{90}/day.

TABLE 2.—STRONTIUM-90 AND CALCIUM-LEVELS OF DIET

San Francisco, August 1960

Food type	Annual consumption (kg/yr)	Calcium		Strontium-90			Food type	Annual consumption (kg/yr)	Calcium		Strontium-90		
		gm/kg original material	gm/year	μμc/kg original material	μμc/gm Ca	μμc/year			gm/kg original material	gm/year	μμc/kg original material	μμc/gm Ca	μμc/year
Whole grain products	11	0.99	10.9	5.2	5.2	57	Fruit Juices	19	0.11	2.1	2.0	18.3	38
Refined grain products	37	1.00	37.0	4.5	4.5	167	Fruit—fresh	68	.27	18.4	1.0	3.6	68
Refined grain flour	43	.19	8.2	4.0	21.5	172	Rice	3	.56	1.7	1.9	3.2	6
Milk—liquid	221	1.08	238.7	1.9	1.8	420	Eggs	16	.61	9.8	2.3	3.7	37
Potatoes	45	.12	5.4	.6	5.3	27	Fish—fresh	8	.64	5.1	.2	.4	2
Macaroni	3	.22	6.6	3.9	17.6	12	Fish—shell	1	.88	.9	.8	1.0	1
Beans—dried	3	.84	2.5	3.6	4.3	11	Meat	73	.42	30.7	.5	1.3	37
Vegetables—canned	20	.23	4.6	.8	3.3	16	Poultry	17	.58	9.9	1.4	2.5	24
Vegetables—fresh	43	.35	15.1	3.0	8.5	129							
Vegetables—root	17	.31	5.3	.7	2.1	12	Total			414			1,285
Fruit—Canned	26	.05	1.0	1.9	36.0	49							

Averages: 3.1 μμc Sr^{90}/gm Ca; 3.5 μμc Sr^{90}/day.

TABLE 3.—STRONTIUM-90 AND CALCIUM LEVELS OF DIET

Chicago, September 1960

Food type	Annual consumption (kg/yr)	Calcium		Strontium-90			Food type	Annual consumption (kg/yr)	Calcium		Strontium-90		
		gm/kg original material	gm/year	μμc/kg original material	μμc/gm Ca	μμc/year			gm/kg original material	gm/year	μμc/kg original material	μμc/gm Ca	μμc/year
Whole grain products	11	1.04	11.4	16.4	15.8	180	Fruit juices	19	0.11	2.1	2.0	18.4	38
Refined grain products	37	1.25	46.3	9.1	7.3	337	Fruit—fresh	68	.23	15.6	1.6	6.9	100
Refined grain flour	43	.09	3.9	7.9	87.7	340	Rice	3	.25	.8	1.4	5.8	4
Milk—liquid	221	1.09	240.9	5.6	5.1	1,238	Eggs	16	.47	7.5	1.9	4.1	30
Potatoes	45	.10	4.5	2.8	28.4	126	Fish—fresh	8	1.26	10.1	.1	.1	1
Macaroni	3	.26	.8	7.5	2.9	23	Fish—shell	1	.48	.5	.5	1.1	1
Beans—dried	3	1.16	3.5	7.4	6.3	22	Meat	73	.09	6.6	1.0	11.1	73
Vegetables—canned	20	.23	4.6	5.4	23.6	108	Poultry	17	1.04	17.7	2.5	2.4	43
Vegetables—fresh	43	.34	14.6	5.5	16.3	237							
Vegetables—root	17	.16	2.7	3.4	21.1	58	Total			305			2,991
Fruit—canned	26	.05	1.3	.9	18.1	23							

Averages: 7.6 μμc Sr^{90}/gm Ca; 8.2 μμc Sr^{90}/day.

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Strontium-90 Concentration in Bread Purchased in New York City

Health and Safety Laboratory, U.S. Atomic Energy Commission

The following table presents data on strontium-90 concentrations in bread purchased in New York City during August and September 1960. One loaf of each type is purchased daily from a local grocer and the loaves are composited on a monthly basis. Five brands are represented in each month's sample. Previous results were reported in *Radiological Health Data*, volume I, Nos. 7 and 9, and volume II, No. 4.

TABLE 1.—STRONTIUM-90 AND CALCIUM IN BREAD PURCHASED IN NEW YORK CITY

August and September 1960[1]

Month	Calcium (gm/kg of original material)		Strontium-90					
			μμc/kg of original material		μμc/gm Ca		Intake[2] (μμc/day)	
	Whole wheat	White	Whole wheat	White	Whole wheat	White	Whole wheat	White
August	1.14	0.83	21	8	18	10	0.08	0.37
September	.86	1.08	20	10	3	10	.07	.46

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[1] Data taken from Quarterly Summary Report, HASL-111, dated Apr. 1, 1961.

[2] Values calculated by staff of Data Collation and Analysis Unit, DRH, PHS, from U.S. Department of Agriculture data on average daily per capita consumption of 3.6 gm/day of wholewheat bread and 46.2 gm/day of white bread. (See *Radiological Health Data*, Vol. I, No. 5.)

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SECTION III.—MILK

Milk Monitoring Program

Division of Radiological Health, Public Health Service

The original Public Health Service milk monitoring program consisted of 12 sampling stations, of which 9 are still active. Raw milk is spot sampled at these stations. During 1960 a new sampling program of 60 stations was established. Processed milk is sampled at these stations. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Ala., and the Southwestern Radiological Health Laboratory at Las Vegas, Nev., provide analytical services for the new program.

The purposes of the two sampling programs are not the same. The original network was established to develop sampling and radiochemical analytical proficiencies under conditions which would remain similar over a period of time in regard to the source of milk. During the operation of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary. The Public Health Service and the Department of Health, Education, and Welfare acted to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances, the newly designated stations are the same as those which were reported originally. The establishment of the new processed milk area sampling stations does not preclude the need for further raw milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the method of collecting samples, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers many factors including laboratory methodology and collection methods. Until this study has been completed and additional experience has been gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data will normally follow about 4 months after collection of samples because of the time required for shipment, processing, decay product buildup, compilation of the data, and clearance and publication procedures.

Raw Milk Sampling Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment with respect to measuring the amounts of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures which would make them more suitable for larger-scale programs.

The criteria on which the selection of the original sampling stations was based appeared in the discussion sections of all volume I issues of *Radiological Health Data.*

One-gallon raw milk samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analyses. It is estimated that these samples represent 2,000-gallon lots. The concentration of iodine-131, barium-140, cesium-137 and naturally occurring potassium-40 are all currently being measured by gamma scintillation spectroscopy. Total radiostrontium and strontium-90 are determined following radiochemical separations. The amount of strontium-90 is calculated by measuring the buildup of the strontium-90 daughter decay product, yttrium-90, over a 2-week period. Measurements are made in a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-89 calculated as the difference between this value and strontium-90. Stable calcium is also determined.

April through September 1960 issues of *Radiological Health Data* list references for technical descriptions of the methodology of analyses used.

January 1961 data for the raw milk sampling stations are presented in table 1.

Processed Milk Area Sampling Stations

The monitoring of milk has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. Each city has been selected to provide adequate coverage with respect to production areas and the consuming population. The emphases on this expanded sampling and radioassay program are—

1. Measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant, and
2. Providing one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving milk production and milkshed area characteristics.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from 1 day's sales per month in a community which would be as representative of the total supply as could be achieved under practical conditions. Each sample is a composite of those plants supplying not less than 90 percent of a city's milk supply. The contribution from each plant to the total sample is approximately proportional to volume of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analyses to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 States generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the Western States. Figure 1 shows the locations of these stations.

At the present time radioassays for Sr^{89}, Sr^{90}, Cs^{137}, Ba^{140} and I^{131} are being performed. To date, the latter two isotopes have been below present limits of detection. Other radionuclides of concern to public health agencies will be included for assay as necessary for more complete monitoring of the milk supply.

January 1961 data from the two laboratories are presented in table 2.

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TABLE 1.—RADIOACTIVITY IN MILK—RAW MILK SAMPLING STATIONS

Public Health Service Milk Monitoring Program, Robert A. Taft Sanitary Engineering Center, January 1961

[Average concentrations in $\mu\mu c$/liter]

Area	Calcium (grams/liter)		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	January	Yearly average	January	Yearly average	January	Yearly average	January	Yearly average	January	Yearly average	January	Yearly average
Atlanta, Ga.	1.23	1.13	ND[1]	<10	ND	<5	13	15	ND	<10	25	25
Austin, Tex.	1.22	1.11	ND	<10	ND	<5	4	4	ND	<10	ND	15
Chicago, Ill.	1.16	1.10	ND	<10	ND	<5	4	9	ND	<10	15	30
Cincinnati, Ohio	1.23	1.14	ND	<10	ND	<5	8	10	ND	<10	10	20
New York, N.Y.	1.14	1.10	ND	<10	ND	<5	8	9	ND	<10	15	25
Sacramento, Calif.	1.17	1.13	ND	<10	ND	<5	4	3	ND	<10	ND	10
Salt Lake City, Utah	1.19	1.12	ND	<10	ND	<5	3	6	ND	<10	5	25
Spokane, Wash.	1.23	1.13	ND	<10	ND	<5	5	10	ND	<10	15	25
St. Louis, Mo.	1.20	1.21	ND	<10	ND	<5	13	17	ND	<10	20	30

[1] ND—No detectable activity.

FIGURE 1.—PROCESSED MILK AREA SAMPLING STATIONS

Public Health Service

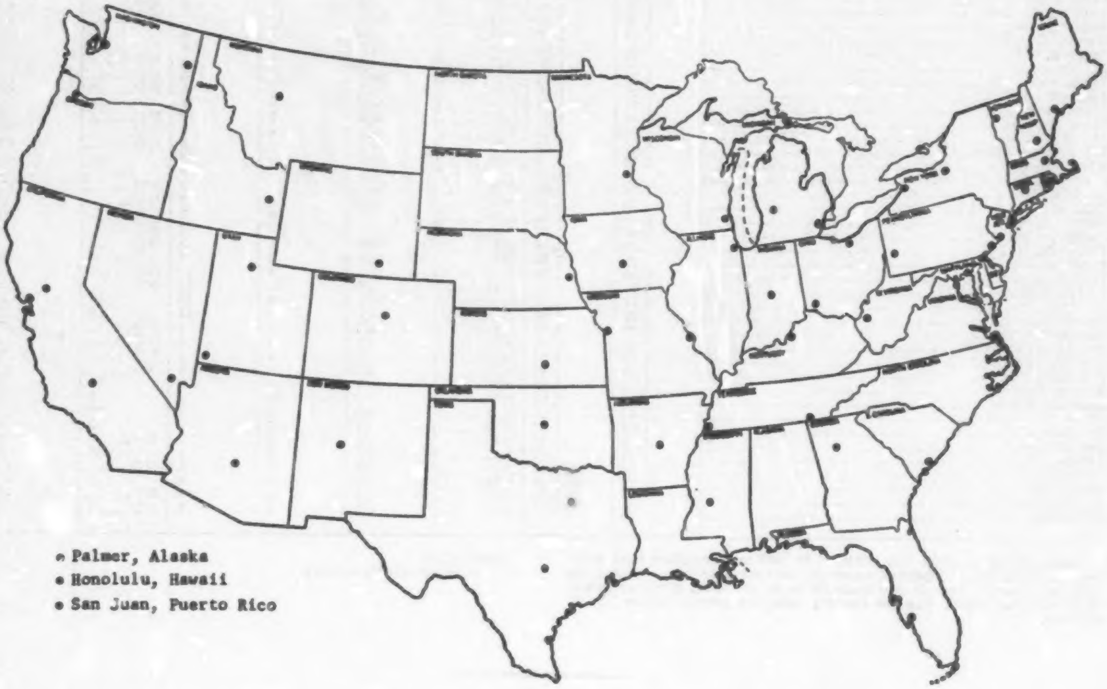

TABLE 2.—RADIOACTIVITY IN MILK—PROCESSED MILK AREA SAMPLING STATIONS, JANUARY 1961

Milk Monitoring Program, Public Health Service

[Radioactivity concentrations in µµc/liter]

Area	Calcium grams/liter		Strontium-89		Strontium-90		Cesium-137	
	January	Average to date [1]	January	Average to date [1]	January	Average to date	January	Average to date
Albuquerque, N. Mex	1.13	1.10	ND [3]	<5	6	4	ND	<5
Atlanta, Ga	1.25	1.24	ND	<5	8	9	ND	<5
Austin, Tex	1.32	1.20	ND	<5	2	2	ND	<5
Baltimore, Md	1.43	1.21	ND	<5	6	7	10	<5
Boston, Mass	1.24	1.20	ND	<5	8	11	10	15
Buffalo, N.Y	1.20	1.18	ND	<5	6	6	ND	<5
Burlington, Vt	1.20	1.20	ND	<5	6	8	ND	10
Charleston, S.C	1.38	1.29	ND	<5	7	10	ND	5
Charleston, W. Va	1.22	1.10	ND	<5	6	9	ND	<5
Charlotte, N.C	1.28	1.24	ND	<5	10	12	ND	5
Chattanooga, Tenn	1.34	1.32	ND	<5	10	10	ND	<5
Chicago, Ill	1.16	1.15	ND	<5	6	6	ND	<5
Cincinnati, Ohio	1.27	1.19	ND	<5	7	8	ND	<5
Cleveland, Ohio	1.24	1.17	ND	<5	7	7	ND	<5
Dallas, Tex	1.28	1.23	ND	<5	4	6	ND	<5
Denver, Colo	1.10	1.10	ND	<5	4	6	5	10
Des Moines, Iowa	1.13	1.06	ND	<5	8	8	ND	15
Detroit, Mich	1.18	1.17	ND	<5	6	7	ND	<5
Grand Rapids, Mich	1.22	1.24	ND	<5	7	7	ND	5
Hartford, Conn	1.16	1.19	ND	<5	6	8	5	10
Helena, Mont	1.04	1.08	ND	<5	5	6	ND	10
Honolulu, Hawaii	1.16	1.07	ND	<5	5	5	ND	20
Idaho Falls, Idaho	1.07	1.07	ND	<5	6	5	5	15
Indianapolis, Ind	1.25	1.21	ND	<5	7	6	ND	<5
Jackson, Miss	1.38	1.32	ND	<5	11	12	ND	<5
Kansas City, Mo	1.14	1.07	ND	<5	7	8	5	10
Laramie, Wyo	1.08	1.06	ND	<5	3	5	ND	5
Las Vegas, Nev	1.07	1.04	ND	<5	1	2	ND	<5
Little Rock, Ark	1.24	1.21	ND	<5	12	13	ND	<5
Louisville, Ky	1.24	1.20	ND	<5	8	9	ND	<5
Manchester, N.H	1.19	1.22	ND	<5	9	11	20	25
Memphis, Tenn	1.32	1.27	ND	<5	7	10	ND	<5
Milwaukee, Wis	1.20	1.18	ND	<5	6	6	ND	<5
Minneapolis, Minn	1.05	1.05	ND	<5	5	8	ND	<5
New Orleans, La	1.33	1.26	ND	<5	10	13	10	<5
New York, N.Y	(2)	1.14	(2)	<5	(2)	9	(2)	5
Norfolk, Va	1.28	1.21	ND	<5	7	9	ND	<5
Oklahoma City, Okla	1.28	1.19	ND	<5	6	7	ND	<5
Omaha, Nebr	1.08	1.05	ND	<5	6	7	ND	5
Palmer, Alaska	1.15	1.07	ND	<5	8	7	ND	10
Philadelphia, Pa	1.26	1.18	ND	<5	6	8	ND	5
Phoenix, Ariz	1.06	1.08	ND	<5	3	4	ND	10
Pittsburgh, Pa	1.19	1.21	ND	<5	8	12	ND	5
Portland, Maine	1.24	1.15	ND	<5	10	11	ND	15
Portland, Oreg	1.11	1.12	ND	<5	9	10	10	25
Providence, R.I	1.23	1.21	ND	<5	9	11	15	10
Sacramento, Calif	1.22	1.09	ND	<5	4	5	ND	<5
Salt Lake City, Utah	1.10	1.16	ND	<5	4	6	ND	5
San Francisco, Calif	1.03	1.11	ND	<5	3	4	ND	10
San Juan, P.R	1.14	1.16	ND	<5	4	4	ND	<5
Seattle, Wash	1.12	1.09	ND	<5	6	8	10	25
Spokane, Wash	1.14	1.09	ND	<5	10	8	5	15
St. George, Utah	1.14	1.06	ND	<5	2	4	10	5
St. Louis, Mo	1.02	1.04	ND	<5	7	7	10	30
Syracuse, N.Y	1.13	1.22	ND	<5	6	7	ND	10
Tampa, Fla	1.31	1.27	ND	<5	6	5	40	70
Trenton, N.J	1.22	1.23	ND	<5	6	8	ND	<5
Washington, D.C	1.22	1.18	ND	<5	6	8	5	<5
Wichita, Kans	1.10	1.08	ND	<5	3	6	ND	<5
Wilmington, Del	1.24	1.21	ND	<5	8	8	ND	5

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[1] Because this program was initiated in 1960 and sampling necessarily became operative in a staggered sequence, the averages shown represent all analyses to date. Average will normally be for the latest 12-month period after sampling began. For the January data, the average covers 5 to 11 analyses.

[2] Sample lost.

[3] ND—No detectable activity.

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Radioactivity in Milk

Health and Safety Laboratory, U.S. Atomic Energy Commission

The results of the Atomic Energy Commission's Health and Safety Laboratory's routine milk monitoring program at four locations in the United States for September, October, and November 1960 are presented in table 1. Data for previous months appear in *Radiological Health Data*, volume I, Nos. 1, 2, 3, 5, 7 and 8, and volume II, No. 3.

The Health and Safety Laboratory has published a correction for the results of the August 1960 sample collected at Perry, N.Y., included in the data in volume II, No. 3. The corrected results are shown in table 1.

TABLE 1.—STRONTIUM-90 AND CALCIUM IN MILK SAMPLES, 1960[1]

Health and Safety Laboratory

Sampling station and month	Strontium-90			Calcium	
	µµc/liter	µµc/kg	µµc/gmCa	gm/liter	gm/kg
Perry, N.Y. (powdered milk):					
August (correction)	------	49.7	5.5	------	9.1
September	------	39.7	4.96	------	8.0
October	------	45.6	5.10	------	8.95
November	------	37.8	4.17	------	9.06
New York City (liquid milk):					
September	6.3	------	6.1	1.03	------
October	6.2	------	6.1	1.02	------
November	6.4	------	5.9	1.09	------
Mandan, North Dakota (powdered buttermilk):					
September	------	100	9.1	------	11.0
October	------	84	8.1	------	10.4
November	------	109	9.1	------	11.9
Honolulu, Hawaii[2] (liquid milk):					
September	3.7	------	3.4	1.1	------
	2.4	------	2.3	1.0	------
October	2.4	------	2.2	1.1	------
	2.5	------	2.7	1.0	------
November	2.8	------	2.7	1.0	------
	1.9	------	1.8	1.0	------

[1] Data from quarterly Summary Report, HASL-111, dated Apr. 1, 1961.

[2] 2 results per month representing milk from 2 dairies.

Strontium-90 in Bovine Milk From Minnesota

Division of Environmental Sanitation, Minnesota Department of Health

The Minnesota Department of Health, Division of Environmental Sanitation, initiated an intrastate bovine milk surveillance network in September 1958. Two-ounce samples, collected daily at each of the network stations, are composited and analyzed monthly. Collection is made at the bottling machines so that the sample is randomly representative of the milk produced in that milkshed.

Results for the period January through April 1960 were published in *Radiological Health Data*, Volume I, Number 9. The most recently reported data from this network are presented below.

TABLE 1.—STRONTIUM-90 IN BOVINE MILK FROM MINNESOTA

May–November 1960

[Concentrations in µµc/liter]

Month	Brainerd	Duluth	Minneapolis	Thief River Falls	Worthington	Rochester
May	------	------	5.4	17.9	9.4	9.2
June	16.9	12.5	9.7	7.8	8.8	5.0
July	10.6	12.1	8.3	------	8.6	5.7
August	------	7.4	6.2	7.3	4.9	6.4
September	------	11.0	3.9	4.4	3.7	3.7
October	------	9.9	6.2	6.2	5.5	5.0
November	------	12.6	6.4	6.2	4.2	4.6

SECTION IV.—WATER

National Water Quality Network

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network was established under the provision of section 4(c) of Public Law 660, which states "* * * The Surgeon General shall * * * collect and disseminate basic data * * * (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local health agencies, was started in October 1957. At present, there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses. Some of these stations are on interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately, a total of 250 to 300 stations will be in operation. A few of the more recently established stations have not begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The levels of radioactivity associated with dissolved solids provide a rough measure of levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River.

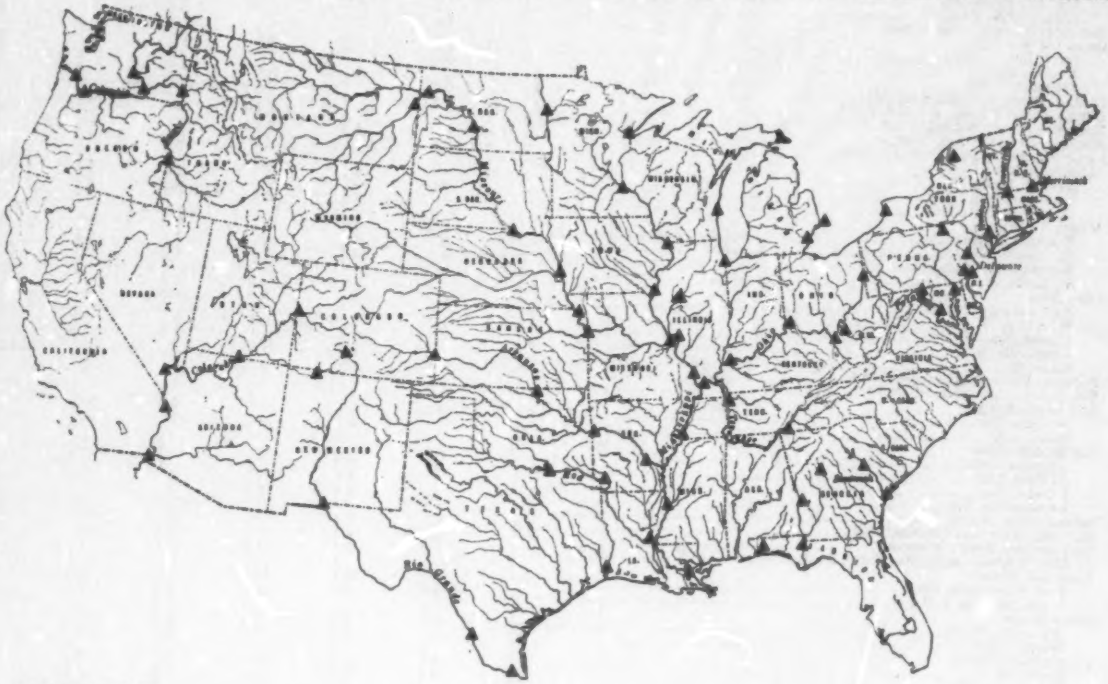
While beta determinations for the first 2 years of the Network operation have been conducted on each sample weekly, the alpha determinations are reported generally on a composite sample of more than 1 week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two or more weekly samples. The alpha data are reported for 3-month composite samples, with one-quarter of the stations being covered each month. All the data reported in table 1 represent the average of all information available for the month indicated.

Strontium-90 data reported are the results of determinations on composite samples for a 3-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $1.50.
2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, volume 1, May 1959, pages 167–169.
3. Setter, L. R., Regnier, J. E., and Diephaus, A., "Radioactivity of Surface Waters in the United States," Jour. AWWA *51.* 1377 (1955).
4. Straub, C. P., Setter, L. R., Goldin, S., and Hallbach, P. F., "Strontium-90 in Surface Waters," Jour. AWWA *52*, 756 (1956).
5. Setter, L. R., and Baker, S. L., "Radioactivity of Surface Waters in the United States," *Radiological Health Data,* volume I, No. 7 (1960).

FIGURE 1.—PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS



As of June 30, 1960

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

National Water Quality Network, Public Health Service

[Concentrations in μμc/liter]

Station	Quarter ending Dec. 31, 1960	December 1960					
	Strontium-90	Beta activity			Alpha activity		
		Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River: Cedar Hill, N. Mex.		111	35	146	29	26	25
Chattahoochie River:							
Atlanta, Ga.	2.3	0	0	0			
Columbus, Ga.		0	<1	<1	0	2	2
Colorado River:							
Loma, Colo.		0	0	0	0	11	11
Page, Ariz.	.4	0	20	20	<1	17	18
Hoover Dam, Ariz.-Nev.		0	10	10	0	13	13
Parker Dam, Ariz.-Calif.	1.2	0	10	10	0	10	10
Yuma, Ariz.		0	0	0	0	8	8
Columbia River:							
Pasco, Wash.		54	724	778			
Bonneville Dam, Oreg.	.5	27	401	428	1	2	3
Clatskanie, Oreg.		3	137	140			
Delaware:							
Martin's Creek, Pa.		0	0	0			
Philadelphia, Pa.		3	3	6	1	1	2
Escambia River: Century, Fla.	(1)	0	0	0	0	0	0
Great Lakes:							
Gary, Ind.		0	0	0	0	0	0
Detroit, Mich.		0	0	0	0	1	1
Milwaukee, Wis.	.2	0	1	1	0	0	0
Hudson River: Poughkeepsie, N.Y.	.4	0	0	0			
Illinois River: Peoria, Ill.	.5	0	0	0	1	3	4
Kanawha River: Winfield Dam, W. Va.		0	0	0	0	1	1
Klamath River: Copco, Oreg.		0	4	4	<1	1	2
Little Miami River: Cincinnati, Ohio	(1)	0	0	0	0	2	2
Mississippi River:							
East St. Louis, Ill.		0	0	0	0	2	2
Cape Girardeau, Mo.		0	9	9	2	7	9
West Memphis, Ark.	1.0	0	4	4	1	2	3
Missouri River:							
Yankton, S. Dak.		0	1	1	0	13	13
St. Joseph, Mo.	.5	0	5	5	1	6	7
Kansas City, Kans.		0	5	5	3	3	6
St. Louis, Mo.		0	0	0			
Ohio River:							
East Liverpool, Ohio		0	3	3			
Wheeling, W. Va.	.6						
Huntington, W. Va.	.4	0	0	0	0	1	1
Evansville, Ind.	.8	0	<1	<1	0	<1	<1
Cairo, Ill.		2	9	11			
Potomac River: Williamsport, Md.		0	0	0	0	0	0
Red River, North: Grand Forks, N. Dak.		0	7	7	1	7	8
Red River, South:							
Denison, Tex.	.7	0	0	0	0	10	10
Index, Ark.		11	3	14	7	4	11
Rio Grande River:							
Alamosa, Colo.		0	0	0	<1	2	3
El Paso, Tex.		0	0	0			
Laredo, Tex.		0	5	5	9	5	14
Brownsville, Tex.		2	0	2	0	10	10
Sabine River: Ruliff, Tex.		0	4	4	<1	0	<1
St. Clair River: Port Huron, Mich.		0	0	0	0	<1	<1
St. Lawrence River: Massena, N.Y.	.6	0	1	1	0	<1	<1
St. Mary's River: Sault Ste. Marie, Mich.		0	2	2	0	1	1
Savannah River:							
Port Wentworth, Ga.	.5	0	16	16			
North Augusta, S.C.		0	0	0	0	0	0
Snake River:							
Wawawai, Wash.		0	0	0	0	6	6
Weiser, Idaho	.2	0	0	0	0	6	6
Susquehanna River:							
Sayre, Pa.		0	0	0	0	0	0
Conowingo, Md.	.4	0	5	5	0	1	1
Tennessee River:							
Chattanooga, Tenn.	.9	0	47	47			
Bridgeport, Ala.		0	69	69	0	1	1
Yellowstone River: Sidney, Mont.		0	0	0	[illegible]	10	14

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[1] Insufficient sample for analysis.

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Monitoring of Water Supplies Around the Nevada Test Site

By contract with the Atomic Energy Commission the Public Health Service has conducted an offsite monitoring program around the Nevada Test Site (NTS) since 1955. Included in the program have been measurements of radioactivity in water supplies. These data have been reported in the Atomic Energy Commission's 13th, 14th, 18th and 23d semiannual reports to Congress and by the Public Health Service in the 1957 Congressional Hearings entitled, "The Nature of Radioactive Fallout and Its Effects on Man."

Figure 1 summarizes gross beta measurements in water supplies located in the NTS offsite area for the 2-month period, January–February 1961.

The lower limit of detectability with the equipment used is about 10 micromicrocuries per liter.

TABLE 1.—DESCRIPTION OF WATER SAMPLING POINTS, *Nevada Test Site*

Location	Source	Population served
Las Vegas	13 wells—650′ to 1,250′ depth plus Lake Mead supply.	40,000.
Game Reserve	400′ drilled well	20.
Indian Springs	600′ drilled well	Average 250.
Pahrump	75′ driven well	10–50.
Ash Meadows	Spring 25′ deep	8.
Lathrop Wells	3 wells—600′ deep	Average 15.
Beatty	Spring	550.
Lida Junction	125′ drilled well	2–10.
Goldfield	Spring	Average 200.
Tonapah	2 drilled wells—60′ depth	Average 1,500.
Warm Springs	Multiple springs—no improvement	10.
Diablo	Well	State Highway Station.
Lincoln Mine	2 driven wells	3.
Caliente	Springs	Average 10–12.
Crystal Springs	Free flowing spring	0.
Alamo	2 wells—50′–67′ deep	Average 175.
Pahranagat Lake	Surface	Not used for domestic purposes.
Butler Ranch	Flowing spring	1.
Warm Spring Ranch	Flowing spring from earth fault	Public park with swimming pool.
Logandale	Drilled well	300.
Ballistic Range	do	10–15.

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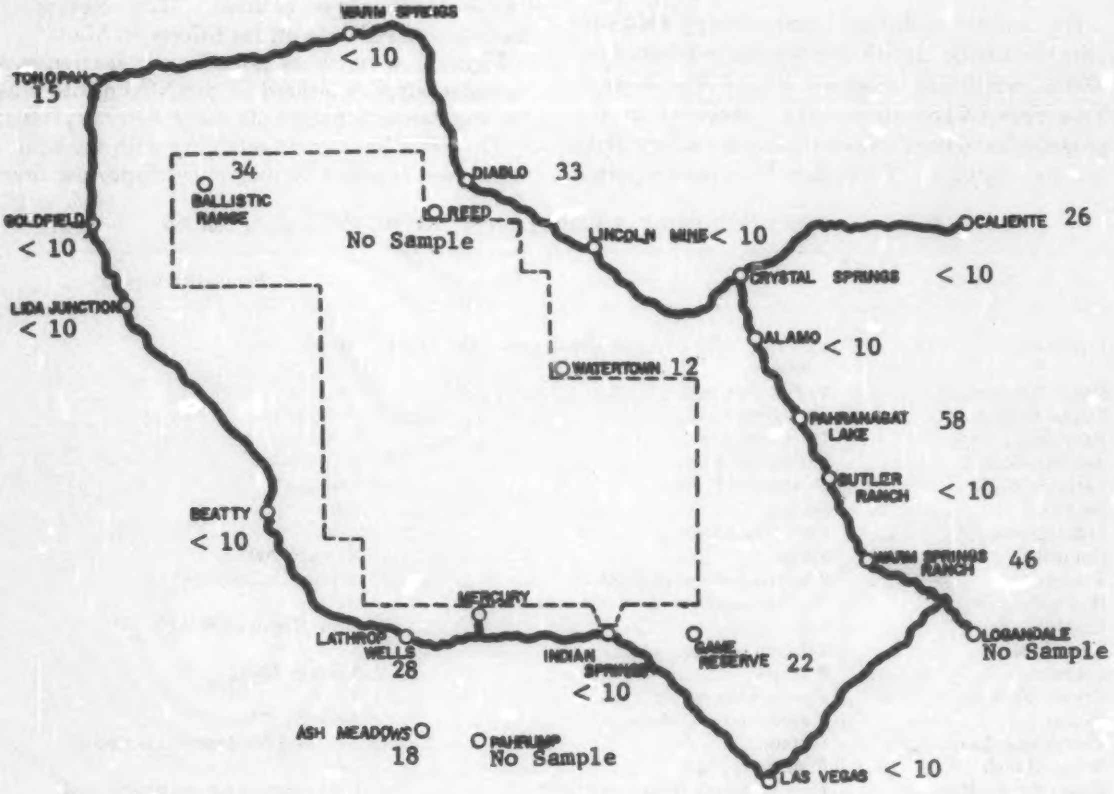
Figure 1.—GROSS BETA MEASUREMENTS IN WATER SUPPLIES IN OFFSITE AREAS OF THE NEVADA TEST SITE FOR JANUARY–FEBRUARY 1961

[Average concentrations in μμc/liter at time of measurement]


WARM SPRINGS
< 10
TONOPAH
15
34
BALLISTIC RANGE
DIABLO
33
GOLDFIELD
< 10
REED
No Sample
LINCOLN MINE
< 10
CALIENTE
26
CRYSTAL SPRINGS
< 10
LIDA JUNCTION
< 10
ALAMO
< 10
WATERTOWN
12
PAHRANAGAT LAKE
58
BUTLER RANCH
< 10
BEATTY
< 10
WARM SPRINGS RANCH
46
MERCURY
LATHROP WELLS
28
INDIAN SPRINGS
< 10
GAME RESERVE
22
LOGANDALE
No Sample
ASH MEADOWS
18
PAHRUMP
No Sample
LAS VEGAS
< 10

Strontium-90 in Tap Water

Health and Safety Laboratory, Atomic Energy Commission

The Atomic Energy Commission's Health and Safety Laboratory monitors tap water concentrations of strontium-90 in Richmond, Calif., and New York City on a monthly basis. Data for the fourth quarter 1960 are presented below. Previous data for 1960 were given in *Radiological Health Data*, volume I, Nos. 5 and 9, and volume II, No. 4.

Table 1.—STRONTIUM-90 IN TAP WATER, FOURTH QUARTER 1960 [1]

Location	Month	Activity (μμc/liter)
Richmond, Calif. (40 liters per sample)	October	0.26
	November	.28
	December	.26
New York City (100-200 liters per sample)	October	.33
	November	.34
	December	.34

[1] Data from *Quarterly Summary Report, HASL-111*, dated Apr. 1, 1961.

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SECTION V.—OTHER DATA

External Gamma Activity

Radiation Surveillance Network, Public Health Service

Portable survey instruments are available at stations of the Radiation Surveillance Network for recording levels of external gamma radiation. Measurements are made daily approximately 3 feet above the ground. These readings are not precise but are sufficiently accurate to illustrate any significant variations above background. The differences among the values shown in the following table are within the variance anticipated due to differences in normal background and instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY

Public Health Service, Radiation Surveillance Network, January 1961

Station location	Average (mr/hr)	Station location	Average (mr/hr)	Station location	Average (mr/hr)
Anchorage, Alaska	0.01	Iowa City, Iowa	.02	Ponca City, Okla	.04
Fairbanks, Alaska	(1)	Topeka, Kans	.02	Portland, Oreg	.02
Juneau, Alaska	.01	New Orleans, La	.02	Harrisburg, Pa	.01
Phoenix, Ariz	.01	Baltimore, Md	.02	Providence, R.I	.02
Little Rock, Ark	.02	Lawrence, Mass	.02	Columbia, S.C	.02
Berkeley, Calif	.01	Lansing, Mich	.02	Edgemont, S. Dak	(1)
Los Angeles, Calif	.01	Minneapolis, Minn	.01	Pierre, S. Dak	.02
Denver, Colo	.02	Pascagoula, Miss	(1)	Austin, Tex	.01
Hartford, Conn	.01	Jefferson City, Mo	.01	El Paso, Tex	.02
District of Columbia	.02	Helena, Mont	.03	Salt Lake City, Utah	.02
Jacksonville, Fla	.02	Trenton, N.J	(1)	Richmond, Va	.01
Atlanta, Ga	(1)	Santa Fe, N. Mex	.04	Seattle, Wash	.02
Honolulu, Hawaii	.02	Albany, N.Y	.02	Madison, Wis	.01
Boise, Idaho	.01	Gastonia, N.C	.02	Cheyenne, Wyo	.02
Springfield, Ill	(1)	Cincinnati, Ohio	(1)		
Indianapolis, Ind	.01	Oklahoma City, Okla	.02		

[1] No data received.

Radioactivity in the Biota Near Hanford, Hanford Atomic Products Operation

General Electric Co., Richland, Wash.

During operation of the plutonium production and research facilities at the Hanford Atomic Products Operation (HAPO), operated by General Electric Co. for the Atomic Energy Commission, controlled amounts of radioactive wastes are released to the atmosphere, ground, and Columbia River. These wastes contribute to the radiation exposure of persons living in the neighborhood of the controlled area. The protection of these persons from undue radiation exposure attributable to

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Hanford sources is one of the attendant responsibilities in the operation of the Hanford facilities. A summary of results concerning levels of radioactivity in air and water for the environs of Hanford during the calendar year 1959 and the first and second quarters of 1960 appear in *Radiological Health Data*, volume II, No. 5.

The following tables have been abstracted from HAPO's quarterly reports entitled "Evaluation of Radiological Conditions in the Vicinity of Hanford," for the first, second, and third quarters of 1960, issued May 31, August 5, and November 10, 1960 respectively.

These tables present data regarding levels of specific radionuclides in grass, vegetables, alfalfa, milk, fish, fowl, and oysters at selected locations.

Located downstream nearest to the HAPO plant are the Ringold farms and the Riverview Irrigation District, which use Columbia River water for irrigation. These farming areas are located about 15 and 30 miles downstream, respectively, from the nearest reactor. The farms in both areas are relatively small and so diversified that their harvests contribute only a small fraction of produce consumed in nearby communities. However, their locations with respect to the reactors should result in the maximum concentrations of radionuclides in produce for those radionuclides associated with irrigation water.

Atmospheric concentrations generally result in the uptake of radionuclides by plant life. Therefore, the surveillance program at Hanford includes the sampling of native grasses from several locations throughout the Pacific Northwest. These locations are identified as zones in figure 1. The sampling procedure consisted of collecting 15 grams of grass at each of 10 sites throughout a zone. The samples within zones were composited and analyzed by use of a gamma spectrometer. The analytical results are given in table 1.

FIGURE 1.—VEGETATION SAMPLING ZONE LOCATIONS, HANFORD WORKS AND ENVIRONS

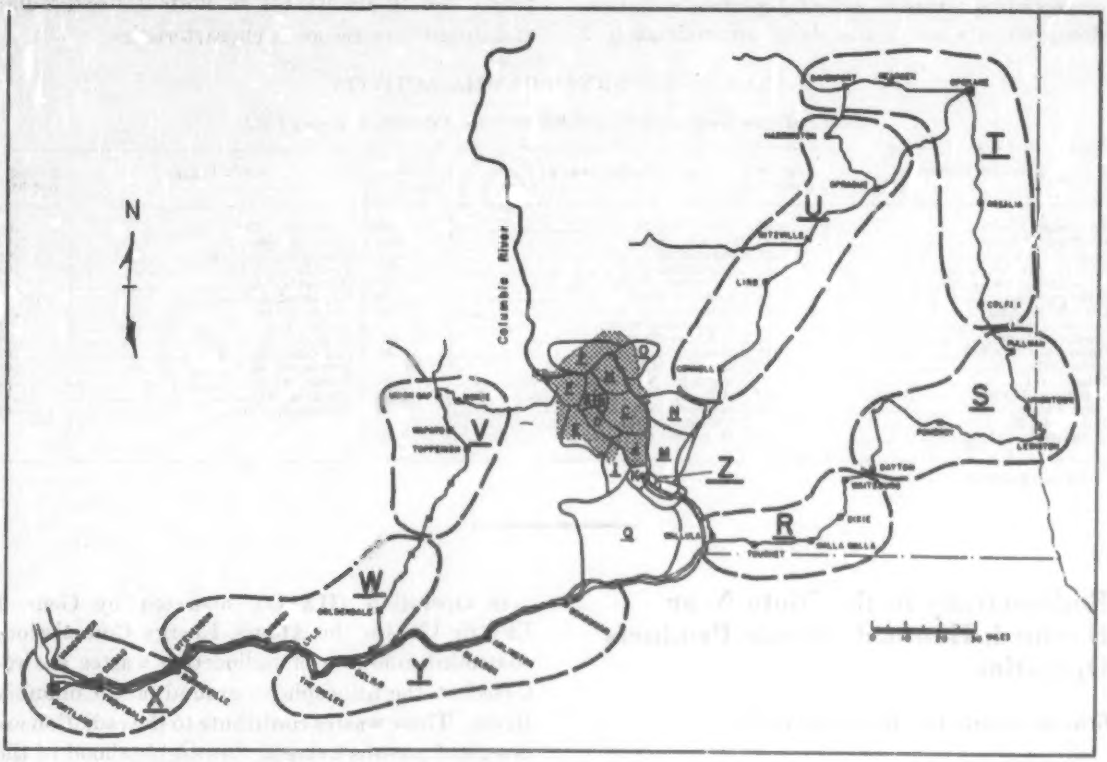
N
Columbia River
T
U
V
W
X
Y
Z
R
S
Q
N
M
SPOKANE
HARRINGTON
SPRAGUE
RITZVILLE
LIND
CONNELL
COLFAX
PULLMAN
DAYTON
WAITSBURG
DIXIE
WALLA WALLA
TOUCHET
WALLULA
POMEROY
LEWISTON
TOPPENISH
GOLDENDALE
STEVENSON
LYLE
THE DALLES
CELILO
PORTLAND
TROUTDALE
0 10 20 30 MILES

TABLE 1.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN NATIVE GRASSES—1960

[Average concentrations in μμc/gm of vegetation]

Radionuclide (s)	Quarter	Statistic	Zone I	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
Ba^{140}-La^{140}	1st	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	2d	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	3d	Number of samples	13	13	13	13	13	13	13	12	8	8	8	8	9	9	9	9
		Average	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Zr^{95}-Nb^{95}	1st	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	2d	Number of samples	15	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	3d	Number of samples	13	13	13	13	14	13	13	13	8	8	8	8	9	9	9	9
		Average	<2.0	<2.0	<2.0	<2.0	<2.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Ru^{103}+Ru^{106}	1st	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	3.7	3.5	3.2	4.6	2.7	4.1	3.1	4.3	4.3	4.7	[illegible]	3.4	<2.0	5.0	6.5	2.6
	2d	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	3d	Number of samples	13	13	13	13	13	13	13	12	8	8	8	8	9	9	9	9
		Average	<2.0	<2.0	<2.0	<2.0	<2.0	2.5	<2.0	<2.0	2.2	2.8	2.5	2.3	<2.0	2.6	3.1	<2.0
I^{131}	1st	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	3.0	2.3	<1.5	1.8	<1.5	1.7	2.5	2.7	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
	2d	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
	3d	Number of samples	13	13	13	13	13	13	13	12	8	8	8	8	9	9	9	9
		Average	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ce^{141}+Ce^{144}	1st	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	10.2	11.2	12.9	12.9	10.2	11.3	12.6	13.4	17.7	21.7	29.5	16.0	6.5	26.7	19.3	13.7
	2d	Number of samples	13	13	13	13	13	13	13	13	3	3	3	3	3	3	3	3
		Average	7.8	<5.0	<5.0	<5.0	<5.0	<5.0	6.4	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.3	<5.0
	3d	Number of samples	13	13	13	13	13	13	13	12	8	8	8	8	9	9	9	9
		Average	6.2	5.4	5.7	7.0	7.1	8.2	6.5	6.5	9.8	10.6	12.5	9.0	5.2	11.5	10.3	7.9

TABLE 2.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN NATIVE GRASSES, ZONE Z, 1960

[Average concentrations in μμc/gm of vegetation]

Quarter	Statistic	Radionuclide(s) Ba^{140}—La^{140}	Zn^{65}	Zr^{95}-Nb^{95}	Cs^{137}	Ru^{103}+Ru^{106}	I^{131}	Cr^{51}	Ce^{141}+Ce^{144}
1st	Number of samples	13	13	13	13	13	13	13	13
	Average	<2.0	1.6	<2.0	1.2	2.7	<1.5	<5.0	12.1
2d	Number of samples	13	13	13	13	13	13	13	13
	Average	<2.0	2.0	<2.0	<1.0	<2.0	<1.5	<5.0	<5.0
3d	Number of samples	13	13	13	13	13	13	13	13
	Average	<2.0	2.9	<2.0	<1.0	<2.0	<1.5	<5.0	5.3

TABLE 3.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN ALFALFA PURCHASED FROM GROWERS AT SELECTED WASHINGTON LOCATIONS, 1960

[Average concentrations in μμc/gm]

Isotope(s)	1st quarter				2d quarter								3d quarter	
	Walla Walla		Spokane		Riverview Irrigation District, Pasco		Ringold		Benton City		Eltopia		Riverview Irrigation District, Pasco	
	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average
Sc^{46}	1	<0.1	2	<0.1	7	0.27	4	0.14	4	<0.1	4	<0.1	7	0.28
K^{40}	1	15	2	7.7	7	8.2	4	8.0	4	4.9	4	6.8	7	7.6
Zn^{65}	1	<0.1	2	<.1	7	2.2	4	2.4	4	<.1	4	.2	7	1.7
Zr^{95}-Nb^{95}	1	.17	2	.84	7	<.1	4	.1	4	<.1	4	<.1	7	.2
Cs^{137}	1	.12	2	.16	7	<.05	4	.05	4	<.05	4	<.05	7	<.05
$Ru^{103}+Ru^{106}$	1	1.6	2	2.2	7	<.5	4	.5	4	<.5	4	.5	7	.7
I^{131}	1	<.1	2	<.1	7	<.1	4	<.1	4	.1	4	.1	7	<.1
Cr^{51}	1	<.5	2	<.5	7	5.4	4	3.5	4	<.5	4	<.5	7	19.6
$Ce^{141}+Ce^{144}$	1	1.4	2	3.1	------	[1] NA	------	NA	------	NA	------	NA	------	NA
$Ce^{144}-Pr^{144}$	------	[1] NA	------	NA	7	1.1	4	1.6	4	<.5	4	.4	7	1.8
Sr^{89}	1	.09	2	.12	2	[2] .20	4	[3] NC	4	NC	1	<.01	4	.02
Sr^{90}	1	.15	2	.14	2	[2] .35	4	NC	4	NC	1	.03	4	.07
P^{32}	------	NA	2	NA	5	.34	3	.56	3	.06	3	<.01	7	1.44

[1] NA—Not analyzed.
[2] Questionable results.
[3] NC—Analysis not completed at time of report.

TABLE 4.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN VEGETABLES PURCHASED FROM GROWERS AT SELECTED WASHINGTON LOCATIONS, 3D QUARTER 1960

[Average concentrations in μμc/gm vegetable]

Location	Crop	Sc^{46}		K^{40}		Zn^{65}		Zn^{95}-Nb^{95}		Cs^{137}		$Ru^{103}+Ru^{106}$	
		Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average
Riverview Irrigation District.	Beets	1	<0.1	1	4.2	1	<0.1	1	0.49	1	<0.05	1	<0.5
	Cantaloupes	2	<.1	2	3.6	2	.18	2	<.1	2	<.05	2	<.5
	Carrots	3	<.1	3	4.0	3	.11	3	.19	3	<.05	3	<.5
	Corn	4	.21	4	1.9	4	.95	4	<.1	4	<.05	4	<.5
	Cucumber	1	<.1	1	1.3	1	<.1	1	<.1	1	<.05	1	<.5
	Grapes	1	<.1	1	3.2	1	.10	1	<.1	1	<.05	1	<.5
	Peaches	1	<.1	1	2.1	1	<.1	1	<.1	1	<.05	1	<.5
	Tomatoes	2	<.1	2	2.3	2	<.1	2	<.1	2	<.05	2	<.5
	Watermelon	1	<.1	1	1.8	1	.15	1	<.1	1	<.05	1	<.5
Benton City	Apricots	1	<.1	1	2.8	1	<.1	1	<.1	1	<.05	1	<.5
	Barley	1	<.1	1	5.5	1	.13	1	<.1	1	<.05	1	<.5
	Cabbage	1	<.1	1	2.3	1	<.1	1	<.1	1	<.05	1	<.5
	Corn	3	<.1	3	2.6	3	<.1	3	<.1	3	<.05	3	<.5
	Cucumbers	2	<.1	2	1.3	2	<.1	2	<.1	2	<.05	2	<.5
	Peaches	1	<.1	1	2.0	1	<.1	1	<.1	1	<.05	1	<.5
	Pears	1	<.1	1	1.8	1	<.1	1	<.1	1	<.05	1	<.5
	Tomatoes	1	<.1	1	1.3	1	<.1	1	<.1	1	<.05	1	<.5
	Rye	1	<.1	1	4.4	1	.15	1	<.1	1	<.05	1	<.5
	Wheat	1	<.1	1	4.2	1	.12	1	<.1	1	<.05	1	<.5
Ringold and vicinity	Apricots	3	<.1	3	2.2	3	<.1	3	<.1	3	<.05	3	<.5
	Corn	1	<.1	1	1.9	1	.21	1	<.1	1	<.05	1	<.5
	Peaches	1	<.1	1	2.0	1	<.1	1	<.1	1	<.05	1	<.5

Location	Crop	I^{131}		Cr^{51}		$Ce^{141}+Ce^{144}$		Sr^{89}		Sr^{90}		P^{32}	
		Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average
Riverview Irrigation District.	Beets	1	<0.1	1	0.72	1	<0.5	1	<0.01	1	0.013	1	[1] SL
	Cantaloupes	2	<.1	2	<.5	2	<.5	2	<.01	2	<.006	2	<.1
	Carrots	3	<.1	3	.90	3	<.5	2	<.01	2	.010	2	.12
	Corn	4	<.1	4	<.5	4	<.5	3	<.01	3	<.006	4	.20
	Cucumber	1	<.1	1	<.5	1	<.5	1	<.01	1	<.006	1	<.1
	Grapes	1	<.1	1	<.5	1	<.5	1	[2] NC	1	NC	1	<.1
	Peaches	1	<.1	1	<.5	1	<.5	1	NC	1	NC	1	<.1
	Tomatoes	2	<.1	2	<.5	2	<.5	1	<.01	1	<.006	2	<.1
	Watermelon	1	<.1	1	<.5	1	<.5	1	NC	1	NC	1	<.1
Benton City	Apricots	1	<.1	1	<.5	1	<.5	1	<.01	1	<.006	1	<.1
	Barley	1	<.1	1	<.5	1	<.5	1	<.01	1	.034	1	<.1
	Cabbage	1	<.1	1	<.5	1	<.5	1	<.01	1	<.006	1	<.1
	Corn	3	<.1	3	<.5	3	<.5	1	<.01	1	<.006	3	<.1
	Cucumbers	2	<.1	2	<.5	2	<.5	2	<.01	2	.006	2	<.1
	Peaches	1	<.1	1	<.5	1	<.5	1	<.01	1	<.006	1	<.1
	Pears	1	<.1	1	<.5	1	<.5	1	<.01	1	<.006	1	<.1
	Tomatoes	1	<.1	1	<.5	1	<.5	1	<.01	1	<.006	1	<.1
	Rye	1	<.1	1	<.5	1	<.5	1	.031	1	.051	1	<.1
	Wheat	1	<.1	1	<.5	1	<.5	1	NC	1	NC	1	<.1
Ringold and vicinity	Apricots	3	<.1	3	<.5	3	<.5	3	<.01	3	<.006	3	<.1
	Corn	1	<.1	1	<.5	1	<.5	1	NC	1	NC	1	<.1
	Peaches	1	<.1	1	<.5	1	<.5	1	<.01	1	<.006	1	<.1

[1] SL—Sample lost.
[2] NC—Analysis not completed at the time of the report.

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TABLE 5.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN MILK PURCHASED FROM PRODUCERS AT SELECTED WASHINGTON LOCATIONS, 1960

[Average concentrations in $\mu\mu$c/gm milk]

Location	K^{40}		Zn^{65}		Cs^{137}		Sr^{89}		Sr^{90}		P^{32}	
	Number samples	Average	Number samples	Avenge	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average
1st quarter												
Riverview Irrigation District:												
Farm 2	8	1.2	8	0.24	8	0.034	5	<0.004	5	0.0045	----------	[1] NA
Farm 3	6	1.0	6	.40	6	< .030	2	< .004	2	.0056	----------	NA
Ringold Farms	6	2.1	6	.32	6	.074	3	< .004	3	.0029	----------	NA
Benton City	2	1.7	2	< .08	2	< .030	2	< .004	2	.0025	----------	NA
Local purchase—commercial milk:												
Brand A	2	1.3	2	< .08	2	< .030	1	< .004	1	.0051	----------	NA
Brand F	2	1.3	2	< .08	2	< .030	1	< .004	1	.0038	----------	NA
Brand H	2	1.3	2	< .08	2	.048	2	< .004	2	.0056	----------	NA
2d quarter												
Riverview Irrigation District:												
Farm 2	3	1.6	3	0.51	3	0.022	1	<0.004	1	0.0057	----------	NA
Ringold Farms	3	1.6	3	.63	3	< .030	1	< .004	1	.0043	----------	NA
Benton City	1	1.8	1	< .08	1	< .030	1	< .004	1	.0051	----------	NA
Local purchase—commercial milk:												
Brand A	2	1.5	2	< .08	2	< .030	1	< .004	1	.0045	----------	NA
Brand F	2	1.5	2	< .08	2	.030	1	< .004	1	.0029	----------	NA
Brand H	2	1.4	2	< .08	2	.039	1	< .004	1	.0140	----------	NA
3d quarter												
Riverview Irrigation District	10	1.3	10	0.75	10	<0.030	2	<0.004	2	0.0029	6	0.96
Ringold Farms	12	1.2	12	.65	12	.025	5	< .004	5	.0033	9	1.40
Benton City	2	1.1	2	< .08	2	< .030	2	NA	2	NA	2	NA
Local purchase—commercial milk: Brand F	3	1.1	3	< .08	3	< .030	3	NA	3	NA	3	NA

[1] NA—Not analyzed.

TABLE 6.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN LOCALLY PURCHASED CONDENSED, EVAPORATED OR FORMULA MILK, WASHINGTON, 1960

[Average concentrations in $\mu\mu$c/gm milk]

Brand	K^{40}				Cs^{137}				Sr^{89}				Sr^{90}			
	2d quarter		3d quarter		2d quarter		3d quarter		2d quarter		3d quarter		2d quarter		3d quarter	
	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average	Number samples	Average
J	1	1.2	1	1.4	1	<0.030	1	0.047	1	<0.004	1	<0.004	1	0.017	1	0.004
C	1	2.6	1	2.6	1	.035	1	.034	1	.013	1	< .004	1	.020	1	.011
L	1	4.3	1	2.5	1	.230	1	< .030	1	< .004	1	< .004	1	.031	1	.008
K	1	2.6	1	2.6	1	.050	1	< .030	1	< .004	1	< .004	1	.014	1	.009
T	1	3.2	1	2.4	1	.071	1	< .030	1	< .004	1	< .004	1	.005	1	.004
P	1	2.3	1	1.7	1	.033	1	.082	1	< .004	1	< .004	1	.032	1	.029

TABLE 7.—CONCENTRATIONS OF P^{32} IN SELECTED ORGANISMS, 1960

[Average concentrations in $\mu\mu c$/gm of wet tissue]

Quarter	Type of fish or water fowl	Location	Number samples	Average
1st	White fish, flesh	River, Ringold area	3	320
	do	River, Priest Rapids area	1	7
	do	River, near reactors	1	21
	Diving ducks	do	7	2,100
	River ducks	do	9	200
	Minnows, entire fish	do	7	1,000
	Salmon, juvenile entire fish	do	1	26
2d	Minnows, entire fish	do	20	3,250
	Salmon, juvenile entire fish	do	11	2,900
3d	Minnows, entire fish	do	10	9,400
	Shiners	do	30	25,000

TABLE 8.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN OYSTERS, WILLAPA BAY' WASHINGTON, THIRD QUARTER 1960

[Average concentrations in $\mu\mu c$/gm]

Isotope(s)	Number samples	Average
Sc^{46}	4	0.13
K^{40}	4	2.6
Zn^{65}	4	56
$Zr^{95}-Nb^{95}$	4	.26
Cs^{137}	4	<.05
$Ru^{103}+Ru^{106}$	4	<.5
I^{131}	4	<.1
Cr^{51}	4	<.5
$Ce^{141}+Ce^{144}$	4	<.5
Sr^{89}	2	<.004
Sr^{90}	2	<.003
P^{32}	3	.06

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission is providing data on environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis. The data are from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Radiological Health Data, volume I, Nos. 8 and 9; and volume II, Nos. 1, 2, 3, 4, and 5 contain summaries for 17 installations. Summaries follow for the Aircraft Nuclear Propulsion Department, Brookhaven National Laboratory and the Feed Materials Production Center for the third and fourth quarters of 1960.

Aircraft Nuclear Propulsion Department

General Electric Co., Cincinnati, Ohio, Issued December 1960 and February 1961

Environmental levels of radioactivity at the Aircraft Nuclear Propulsion Department (ANPD) for 1959 and the first and second quarters 1960 were reported in *Radiological Health Data*, volume I, No. 8 and volume II, No. 2. The following report presents a summary of the data for the third and fourth quarters of 1960 as well as the 1960 annual summary.

The Cincinnati facilities of the ANPD are located within the metropolitan area approximately 11 miles north of the main business district. The buildings lie approximately on the centerline of a wide valley at an elevation of 560 feet above sea level. The east fork of Mill Creek, which flows into the Ohio River, runs several hundred feet east of the buildings. (See figs. 1 and 2.)

Air Monitoring

The offsite (community) monitoring program for alpha and beta-gamma airborne radioactivity is accomplished by the use of a mobile sampling unit. Offsite measurements taken by the mobile unit are considered as a check or verification of the sampling data obtained by the stack effluent air monitoring program.

Sampling is generally confined to the communities and General Electric sites within a 1-mile radius of the ANPD. This area is divided into eight sectors, each of which is subdivided at quarter-mile distances. (See fig. 2.) Choice of an optimum sampling location is based upon consid-

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FIGURE 1.—LOCATION MAP, AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

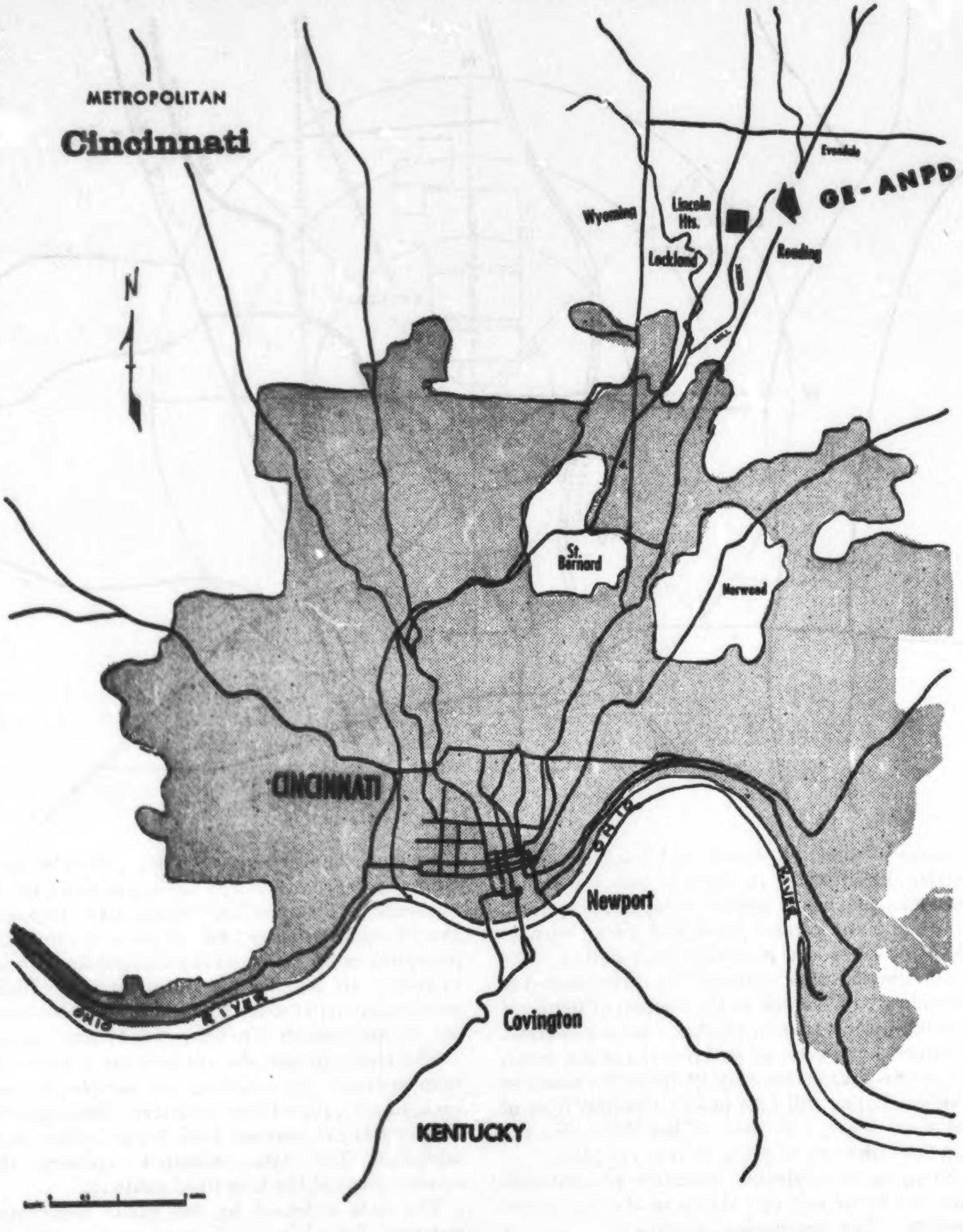
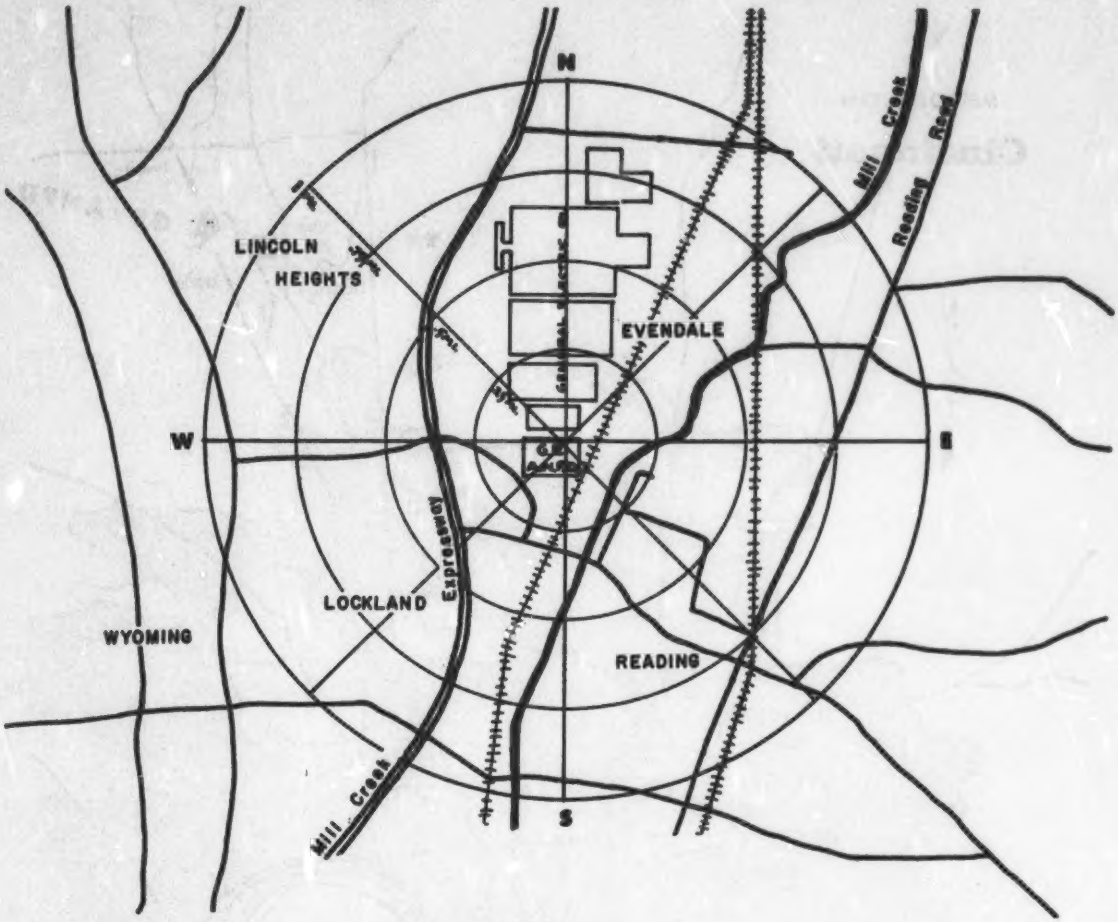

METROPOLITAN
Cincinnati
N
Evendale
GE-ANPD
Wyoming
Lincoln Hts.
Lockland
Reading
St. Bernard
Norwood
CINCINNATI
OHIO RIVER
Newport
Covington
KENTUCKY

FIGURE 2.—SITE MAP, AIRCRAFT NUCLEAR PROPULSION DEPARTMENT



erations of direction, speed, and behavior of the winds. Information on these factors is obtained from an anemometer located on top of the building near the main exhaust stack and telemetered to chart recorders located within the building. The wind-direction trace indicates the direction of the prevailing wind as well as the relation of temperature to altitude, that is, whether a large lapse rate, a normal lapse rate, or an inversion is occurring. These two parameters roughly define the sector in which sampling will take place. Consideration of the wind speed will more or less determine the optimum distance to proceed from the plant.

Sampling is conducted whenever precipitation does not occur and operability of the equipment permits. The monitoring interval is 1 hour at each location with approximately three sets of downwind samples taken each day. Also, on each sampling day a set of upwind background measurements is obtained for comparative purposes. During each sampling interval, three electrostatic precipitators are operated simultaneously in order to collect air samples for alpha activity. Beta-gamma activity is collected on air samples by filtering the air through Whatman No. 41 filter paper.

The alpha air samples are held for 5 days and then analyzed by counting the samples in low background proportional counters. Beta-gamma air samples are counted both 1 and 5 days after sampling. The data presented represent the measurement of the long-lived emitters.

The data obtained by the offsite monitoring program for alpha and beta-gamma airborne radioactivity are presented in table 1. Since airborne radioactivity can arise from many sources, such as natural deposits in the earth, fallout from weapons tests, and discharges from atomic plants, the results obtained from the stack effluent air monitoring program are also presented in table 2.

TABLE 1.—OFFSITE AIRBORNE RADIOACTIVITY

[Average concentrations in μμc/m³]

Period 1960	Upwind				Downwind			
	Alpha		Beta-gamma		Alpha		Beta-gamma	
	Number samples	Activity	Number samples	Activity	Number samples	Activity	Number samples	Activity
3d quarter	105	0.023	105	0.36	132	0.033	132	0.31
4th quarter	156	.023	104	.06	231	.016	154	.08
Annual summary	464	.023	319	.20	786	.024	531	.21

A comparison of upwind and downwind measurements of both long-lived alpha and beta-gamma airborne radioactivity indicates that there are no significant differences between them.

As mentioned above, the offsite airborne monitoring program serves as a verification of the ANPD stack effluent air monitoring program. This program consists of the continuous monitoring of alpha and beta-gamma activity of air exhausted to the environs from laboratory areas where radioactive materials are handled. It should be noted that this air is passed through high efficiency filters prior to monitoring and subsequent release to the outside atmosphere.

During the third and fourth quarters, sampling was conducted in 26 and 27 stacks, respectively. Samples are collected on Whatman No. 41 filter paper under isokinetic conditions. For the main exhaust stacks, filters are changed every 24 hours, or 72 hours for weekends. Samples from other stacks are generally changed weekly.

TABLE 2.—STACK EFFLUENT AIR MONITORING

[Average concentrations in μμc/m³]

Period 1960	Main stack				Secondary stack			
	Number samples	Alpha	Number samples	Beta-gamma	Number samples	Alpha	Number samples	Beta-gamma
3d quarter	112	0.006	112	0.04	207	0.002	54	0.08
4th quarter	100	.002	100	.03	126	.001	36	.06
Calendar year	539	.006	539	.07	838	.001	284	.07

Comparison of average stack effluent air concentrations of alpha and beta-gamma radioactivity with the average downwind concentrations detected in the offsite monitoring program during similar periods of time indicates that the ANPD contributed negligible amounts of radioactivity to the atmosphere. In fact, even without consideration of the dilution that takes place with the atmosphere at the point of release, the effluent concentrations were notably less than the environmental levels both upwind and downwind.

Liquid Effluent Monitoring

Special consideration was given to the disposal of radioactive wastes when the ANPD facilities were designed. An elaborate drainage and retention tank system was designed to give positive assurance that radioactive wastes were not dumped into the local sewerage system. The waste from the laboratory areas flows into one of two sets of retention tanks. The contents of the filled tanks are sampled to determine radioactive concentrations. If the analytical results are below the prescribed control limit for safe disposal, the waste liquid is then passed through an acid neutralization pit before disposal into the sanitary sewerage system. If for any reason the analytical results are above the prescribed control level, the waste is then diluted until within the prescribed levels. Provisions have also been made for pumping wastes not meeting the control level into 55 gallon drums and burying them at a radioactive waste disposal site at Oak Ridge, Tenn. In the 8 years of operation, this method of disposal has not been found necessary.

Table 3 presents the average concentrations of enriched uranium in water passing through the liquid effluent system during the third and fourth quarters of 1960 as well as the 1960 annual summary.

TABLE 3.—RADIOACTIVITY IN LIQUID WASTES

Period 1960	Volume of liquid effluent (gallons)	Uranium (μμc/liter)
3d quarter	1,016,340	1,600
4th quarter	1,052,280	1,500
Calendar year	2,945,100	2,320

General Conclusions

The following conclusions are drawn from the data obtained in the environmental airborne and liquid effluent radioactivity monitoring programs during 1960:

1. The airborne activity in the environs of the ANPD is of a very low level and in accord with typical background levels of natural radioactivity, and

2. Operations at the ANPD contributed an insignificant amount of radioactivity in the liquid waste discharged to the city of Cincinnati sanitary sewerage systems.

Brookhaven National Laboratory

Associated Universities, Inc., Upton, N.Y., Issued December 1960 and March 1961

Environmental levels of radioactivity at the Brookhaven National Laboratory (BNL) have been reported in *Radiological Health Data*, volume I, No. 9 and volume II, No. 2. The following report summarizes the data for the third and fourth quarters of 1960 and the 1960 annual summary.

Laboratory operations affect the levels of natural background radiation in the vicinity of BNL in two ways: (1) by the discharge of coolant air from the graphite-research reactor, and (2) by discharging low levels of radioactive liquid wastes into a small stream.

As a check on the coolant air effluent, radiation levels are monitored at the boundary site. The values presented in table 1 do not include natural background, but represent the reactor's contribution from argon-41 produced in the coolant air.

The limit recommended by the National Committee on Radiation Protection and Measurements (NCRP) for radiation levels in the vicinity of a controlled area is 10 milliroentgens per week averaged over a period of 1 year. Thus, the highest level shown in table 1 for 1960, i.e., 0.72 mr/week, is far below the permissible level.

TABLE 1.—RADIATION LEVELS AT SITE BOUNDARY DUE TO LABORATORY OPERATIONS

[Average values in mr/week]

Period 1960	North gate (600 meters inside boundary)	Southwest perimeter	Southeast perimeter	Northeast perimeter
3d quarter	0.43	0.47	0.28	1.10
4th quarter	.25	.29	.55	.70
Calendar year	.40	.32	.45	.72

The average gross concentrations and total amount of radioactivity in BNL's liquid waste effluent where it leaves the site's boundary are shown in table 2. The liquid wastes produced by BNL operations contain a variety of radioactive substances at very low levels. These wastes are filtered, chlorinated, and released to a small stream that forms one of the headwaters of the Peconic River.

TABLE 2.—GROSS BETA ACTIVITY IN LIQUID WASTE EFFLUENT LEAVING THE BNL SITE

Period 1960	Effluent flow rate (gal/day)	Average concentration (µµc/liter)	Gross beta activity (millicuries)
3d quarter	369,000	300	28.9
4th quarter	302,000	380	39.5
Calendar year	495,000	185	128.6

Feed Materials Production Center

National Lead Co. of Ohio, Fernald, Ohio, Issued February 15, 1961

Environmental levels of radioactivity at the Feed Materials Production Center (FMPC) for 1959 and the first and second quarters of 1960 were reported in *Radiological Health Data*, volume II, No. 4. The following report presents a summary of the data for the third and fourth quarters and the annual summary for 1960.

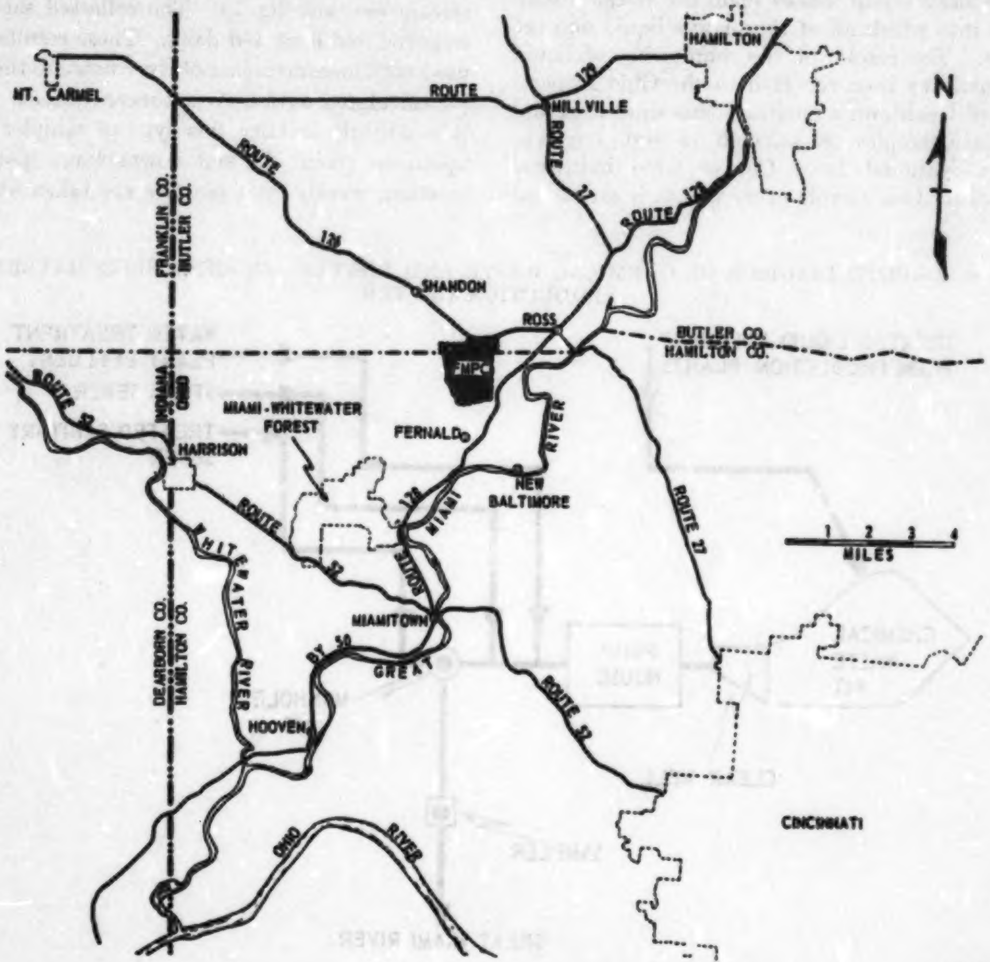
The Feed Materials Production Center is operated by the National Lead Co. of Ohio (NLO) for the Atomic Energy Commission. The project is located in a valley near Fernald in southwestern

Ohio. The production area of FMPC covers an area of 136 acres and is located approximately in the center of a 1,050 acre government-owned site. Most of the site, including the entire production area, is located within Hamilton County, Ohio, but approximately 200 acres are situated in southern Butler County. Adjacent to the site are the small villages of Fernald, New Baltimore, Ross, and Shandon, all being located 1 mile or more from the project. The larger nearby communities of Cincinnati and Hamilton are 20 and 10 air miles respectively (for relative locations see fig. 1).

Operations at this project deal with the processing of high-grade uranium ores and ore concentrates to produce metallic uranium. These processes include: acid digestion of the ores and concentrates, organic phase extraction of uranyl nitrate, subsequent conversion of the uranyl nitrate to uranium oxides and tetrafluorides, reduction to uranium metal, and fabrication of the metal into fuel elements. The project also includes plants for sampling ores and concentrates and recovering uranium from various residues. The final product is used in the United States as a fuel for nuclear reactors.

During the many involved reactions and processes that lead to the reactor fuels, various liquid and airborne wastes are generated which contain varying quantities of uranium. Various inplant methods are used to curtail their release into the environment surrounding the plant. Almost complete removal of the materials is accomplished

Figure 1.—AREA MAP OF RELATIVE LOCATIONS, FEED MATERIALS PRODUCTION CENTER


HAMILTON
MT. CARMEL
ROUTE
MILLVILLE
129
ROUTE 27
ROUTE 129
N
ROUTE 126
FRANKLIN CO.
BUTLER CO.
SHANDON
ROSS
BUTLER CO.
HAMILTON CO.
FMPC
ROUTE 52
INDIANA
OHIO
MIAMI-WHITEWATER
FOREST
FERNALD
RIVER
HARRISON
NEW
BALTIMORE
ROUTE 52
128
MIAMI
ROUTE 27
WHITEWATER
ROUTE
1 2 3 4
MILES
DEARBORN CO.
HAMILTON CO.
MIAMITOWN
BY 50
GREAT
RIVER
ROUTE 52
HOOVEN
CINCINNATI
OHIO
RIVER

by using dust collectors and waste treatment processes. In order to determine the concentrations which reach the area surrounding the project, an environmental survey program has been established which consists of sampling water, soil, and air and performing analyses on the samples that are indicative of released material from the plant. The results of this program indicate that the control of material released to the environs at this site is well within the maximum permissible concentrations (MPC) as recommended by the National Committee on Radiation Protection and Measurements and as adopted by the State of Ohio.

Water Monitoring

Water samples are taken to determine the effect of the site's liquid wastes upon the Great Miami River into which all of the plant's liquid effluent passes. The results of the monitoring of liquid effluent have been reported to the Ohio Department of Health on a monthly basis since 1954 and duplicate samples are taken by a State engineer and a National Lead Co. of Ohio industrial hygienist. One sample every month is exchanged in order that each group can evaluate the other's sampling procedure and analytical results.

Each of the individual production buildings have collection sumps and treatment equipment to remove the uranium from the process waste water. The effluent from the sumps are collected at a central point for equalization. The water passes to a chemical waste pit (see fig. 2), which serves as a settling basin for removal of any remaining settleable solids from the water. The flow which is decanted to the clear-well portion of the pit is virtually free of solids and radioactivity. The effluent is then combined with three other types of project waste water and discharged to the river.

The locations of all water sampling points are shown in figure 3. A weir-type water sampler collects (at point B) samples of the combined stream (see also fig. 2). The collected sample is removed and analyzed daily. These results when used with measurements of river flow are the basis for calculated outfall river concentrations. Since it is difficult to have this type of sampler in an upstream (point A) and downstream (point C) location, weekly spot samples are taken at these

FIGURE 2.—FLOW DIAGRAM OF CHEMICAL WASTE AND DISPOSAL PROCESS, FEED MATERIALS PRODUCTION CENTER

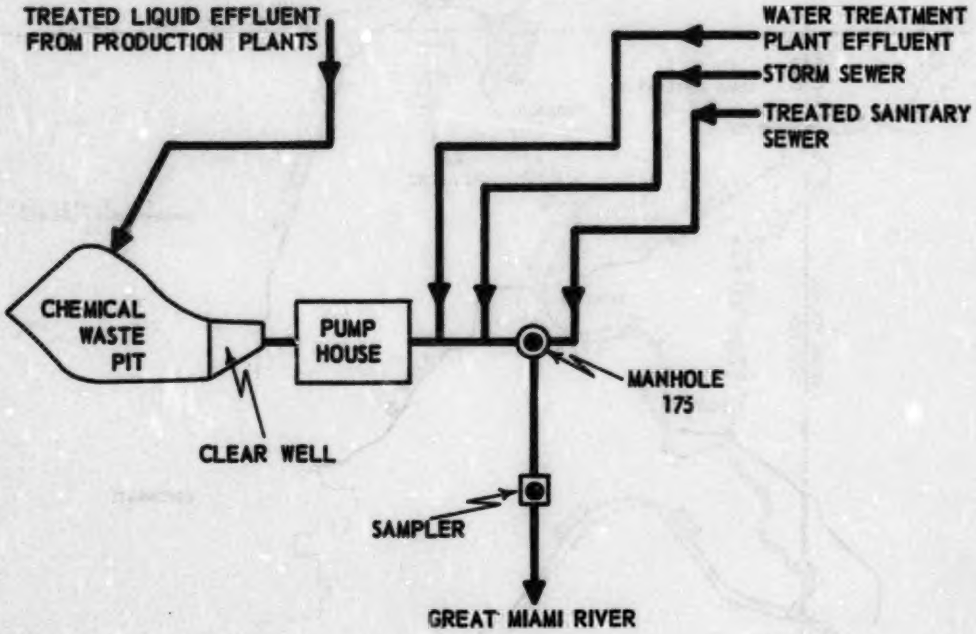


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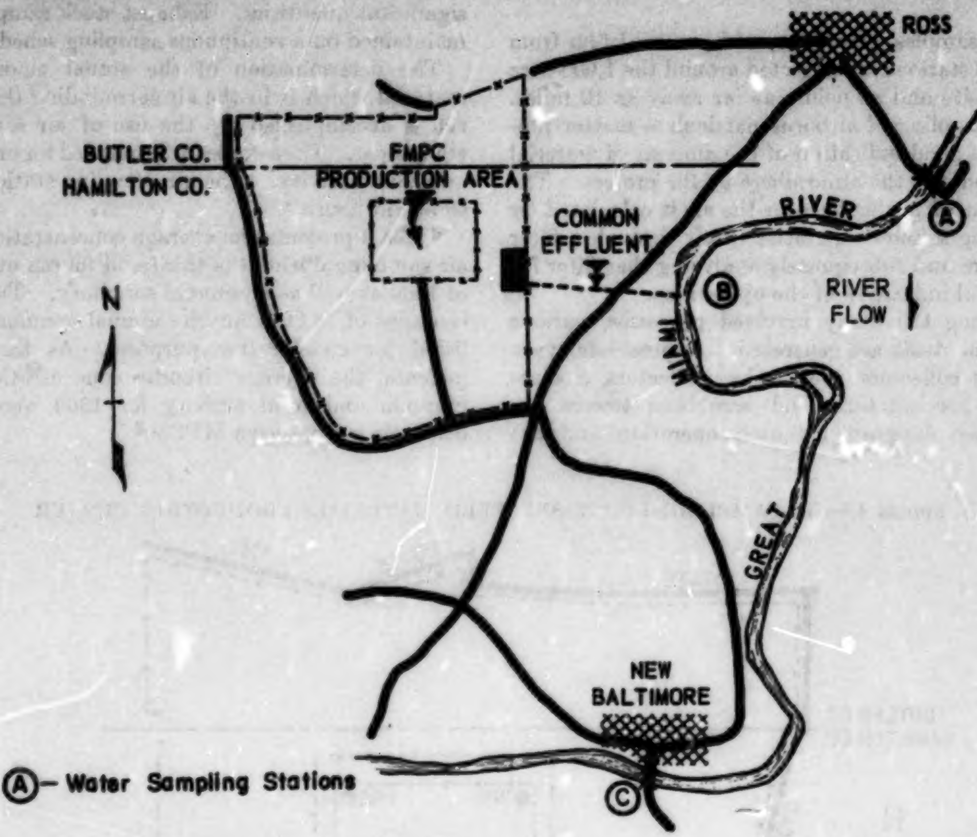
FIGURE 3.—WATER SAMPLING LOCATIONS, FEED MATERIALS PRODUCTION CENTER



points. The collected samples at all points are analyzed for uranium, total activity, chlorides, fluorides, and nitrates.

Table 1 presents the average concentrations of the sampled contaminants during the third and fourth quarters of 1960. The applicable MPC's and the percent of each MPC are also indicated for comparison.

TABLE 1.—RADIOACTIVITY IN GREAT MIAMI RIVER, 1960

[Average concentrations in μμc/liter]

Location (see fig. 3)	3d quarter					4th quarter					Calendar year				
	Number samples	Uranium	Percent MPC	Total activity	Percent MPC	Number samples	Uranium	Percent MPC	Total activity	Percent MPC	Number samples	Uranium	Percent MPC	Total activity	Percent MPC
Upstream (A)	18	12	0.06	36	1.02	19	15	0.08	38	1.30	76	12	0.06	34	1.13
Outfall (B)	92	10	.05	11	.36	92	13	.07	18	.60	364	6	.03	9	.20
Downstream (C)	18	15	.08	41	1.36	19	21	.10	45	1.50	76	18	.09	41	1.36
C minus A		3		4			6		7			6		7	

The data in table 1 indicates that the average calculated concentrations (B) of radioactive liquid waste discharged to the river were 0.6 percent MPC or less. The difference between upstream and downstream concentration (C—A), essentially the same figure as (B) arrived at by river sampling, revealed that liquid discharges averaged 0.23 percent MPC or less. It may be concluded from the data that the FMPC effluent produced little change in the river's quality. The results for 1960 are of the same magnitude as they have been in past years.

Air Monitoring

Air samples, rainwater, and gummed film from fallout stations are collected around the 1,000-acre plant site and at points as far away as 10 miles. The sampling of airborne particulate matter provides a good indication of the amount of material released into the atmosphere by the project. The amount of particulates in the air is calculated by drawing a known quantity of air through a filter medium and subsequently analyzing that filter for material indicative of the operations.

During the many involved processes, various airborne dusts are generated. Appropriate types of dust collectors, such as bag collectors, electrostatic precipitators, and scrubbing towers are specially designed for each operation and are attached to stacks that would have emissions of significant quantities. Exhaust stack sampling is maintained on a continuous sampling schedule.

The determination of the actual amount of material which is in the air surrounding the project is accomplished by the use of air sampling equipment. The samples are analyzed for uranium and total activity. The air sampling stations are shown in figure 4.

Table 2 presents the average concentrations for air sampling during the third and fourth quarters of 1960 as well as an annual summary. The percentages of MPC's for the annual summary are listed for comparative purposes. As the data indicate, the average airborne concentrations of uranium and total activity for 1960 were well below their respective MPC's.

FIGURE 4.—AIR SAMPLING LOCATIONS, FEED MATERIALS PRODUCTION CENTER

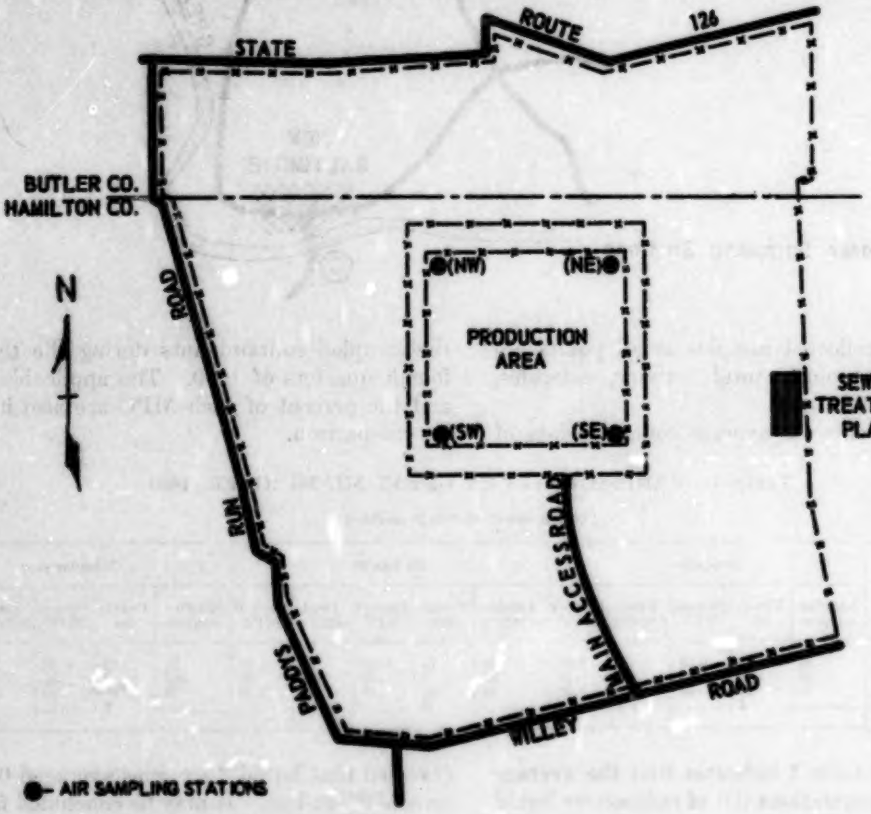


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Table 2.—RADIOACTIVITY OF AIR FILTER SAMPLES, 1960

[Average concentrations in $\mu\mu c/m^3$]

Location	3d quarter			4th quarter			Calendar year				
	Number samples	Uranium	Total activity	Number samples	Uranium	Total activity	Number samples	Uranium	Percent MPC	Total activity	Percent MPC
Southwest	10	0.30	0.31	3	0.51	0.76	13	0.35	17.5	0.59	0.59
Northwest	12	.16	.15	8	.09	.15	20	.16	8.0	.28	.28
Northeast	11	.12	.12	10	.30	.45	21	.19	9.5	.33	.33
Southeast	10	.13	.12	9	.30	.35	19	.21	10.5	.30	.28
Plant average	----------	.17	.17	----------	.30	.44	----------	.23	11.4	.28	.30

Conclusion

During the third and fourth quarters, the concentration of airborne and water activity remained at low levels representative of the first half year. The results for the year are of the same magnitude as they have been in past years. These concentrations of materials present in air and water in the environs surrounding the FMPC project are well below their respective MPC's. Therefore, it may be concluded from this report that the Fernald area operations added insignificant amounts of radioactive materials to the surrounding environment.

Strontium-90 and Cesium-137 Body Burden Studies in Japan

The following tables present the results of assays conducted in Japan for strontium-90 in human bone and cesium-137 in various human tissues.

Data appearing in these tables were abstracted from AEC–tr–4245, entitled, "Annual Report of Scientific Research Grant for 1959 by the Ministry of Education (Government of Japan), No. 13, Radiation Cooperative Research," by Yoshio Hiyama, translated from *Nippon Gakujustu Shinkokai, 79*, 93 (1960).

Table 2 is based on data derived from assays of various bone, muscle, and organs from 13 cadavers (accident victims) during the period from August 1958 through April 1959. Analyses for cesium-137 were conducted on a total of 187 samples. The values listed in column 3 are the arithmetic averages for the number of samples assayed.

Since the number of samples was small and since quite large individual errors were observed, detailed studies could not be made. However, the general opinion that muscle contains large amounts of Cs^{137} was confirmed by this experiment, and it became clear that ribs also contain large amounts of Cs^{137}. The fluctuation of individual values was 0.091–0.95 $\mu\mu c$ Cs^{137}/gm bone. If the arithmetical mean, 0.32 $\mu\mu c$ Cs^{137}/gm bone, is compared with the data for Sr^{90}, it is clear that the concentration of Cs^{137} is 10 times as high as that of Sr^{90} in the human bone. (In this case, the author has compared the data in table 2 to a study conducted by J. L. Kulp at latitudes 20°–40° N during the period 1957–58. A value of 0.19 $\mu\mu c$ Sr^{90}/gm Ca was obtained for that study. Assuming that calcium content is approximately ten percent of adult human bone, Kulp's value becomes 0.019 $\mu\mu c$ Sr^{90}/gm bone.)

The beta ray energy of Sr^{90} (Y^{90}) is higher than that of Cs^{137}. Assuming the same distribution in bone for both species, it may be expected that the radiation dose in bone marrow attributed to cesium-137 is larger than that due to strontium-90. It is also known that cesium has a greater affinity for soft tissue. Therefore, it may be reasonable to assume that cesium is present in bone marrow in higher concentrations. If this assumption is correct, then the bone marrow dose due to cesium-137 becomes higher than that for strontium-90.

Table 1.—STRONTIUM-90 IN HUMAN BONES, OSAKA, JAPAN

Sex	Age	Time of death	Type of bone assayed	Cause of death	μμc Sr^{90}/gm Ca
1 male	0	2d quarter 1957.	Whole bones.	Stillbirth	0.04
Do.	Fetus	2d quarter 1957	do	Abortion	.03
2 female	5 and 7 months				
3 male	Fetus	3d quarter 1957	do	do	.35
	6 and 8 months				
2 male	Fetus	3d-4th quarters 1957	do	do	.41
2 female	6 and 8 months.				
1 female	3 months	1st quarter 1958.	do	Meningitis	.28
1 male	0	do	do	Stillbirth	.02
Do.	57 years	do	Chokan-kotsu[1] (a type of bone) rib and tibia.	Chronic alcoholic toxicosis.	.23
1 female	57 years	do	Rib and Chokan-kotsu[1]	Liver cancer.	.12
1 male	13 years	2d quarter 1958.	Femur	Bankotsu-zuiro[1] (a bone disease).	.51
3 female	0	do	Whole bones.	Weak vitality.	.13
1 female	3 months	do	do	Pyrolus atrophy.	.62
1 male	17 years	do	Femur	Acute pneumonia.	.27
Do.	11 years	do	Whole bones.	Cancerous peritonitis.	.28
2 male	0	2d quarter 1958.	Whole bones.	Stillbirth	0.07
1 female	3 months	do	do	Pneumonia	.05
1 male	0	do	do	Congenital weakness.	.42
Do.	15 years	do	Femur	Suffocation	.28
Do.	18 years	do	Rib and tibia.	Cardioplegia.	.47
2 female	0	do	Whole bones.	Stillbirth	.56
1 female	5 years	do	Femur	Enteritis	.75
Do.	7 months	do	Whole bones.	Pneumonia	1.11
1 male	11 years	do	Femur	Heart asthma.	.30
1 female	15 years	do	do	Heart marasmus.	1.47
Do.	2 years	3d quarter 1958.	Whole bones.	do	.25
1 male	13 years	do	Femur	Leukemia	.75
Do.	7 years	do	do	Pneumonia	1.29
2 female, 1 male.	0	4th quarter 1958.	Whole bones.	Premature	.12
1 female	3 years	do	Chokan-kotsu[1] and rib.	Basal fracture of skull.	1.04
1 male	9months	do	Whole bones.	Dyspepsia	.17
1 female	7 years	do	Femur	Acute pneumonia.	.98
1 male	1 year	do	Whole bones.	Heart	.82

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[1] Transliteration.

Table 2.—CESIUM-137 CONCENTRATIONS IN HUMAN BODY ORGANS, OSAKA, JAPAN

August 1958–April 1959

Organ	Number of samples	μμc Cs^{137}/gm body tissue
Muscle	12	0.212
Ribs	13	.221
Stomach	11	.102
Large intestine	10	.0511
Liver	12	.154
Brain	12	.171
Lung	13	.201
Kidney	12	.162
Heart	13	.184
Spleen	12	.103
Bladder	12	.172
Pancreas	11	.156
Testicle	5	.133
Womb	1	.0623
Thyroid gland	1	.198
Artery	6	.130

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